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THE DREXEL INSTITUTE, PHILADELPHIA.

*By Chauncey M. Depew, LL.D.**

IN the thirteenth century three volumes easily contained all the learning of that period. Now, from twenty-five to thirty books of the largest size, and edited under the most various and able authorship, do not pretend to embrace in their encyclopedia the knowledge and discovery in the world.

In the middle age the people could be broadly divided into two classes, the soldiers and the producers. The labor and skill of the farmer, the merchant and the artisan were exhausted to support the fighter. Education existed only for ecclesiastics. It was wholly the privilege of the Church. As the nations grew more civilized and their wants increased, the priest became also the lawyer and the doctor. The professions gradually emancipated themselves from the priesthood, but, nevertheless, down almost to our own time, higher education, the course in college or in the university, was reserved for the liberal professions. Even among the most enlightened peoples of Europe education is still a privilege. In America it is a duty.

All the conservatism of centuries has crystallized about the university. Every radical effort to break up old systems and proceed upon new lines has met the combined hostility of faculty and alumni. Far be it from me to detract in any way from the glory of that splendid and self-sacrificing body of educators who have made illustrious the title of teacher. But the teachers have been so

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compassed and pinioned by legend, tradition and environment that they have been unable, except within a recent period, to emancipate the curriculum.

The first recognition of the imperative demands of our period was when the optional opportunity broke in upon the time-honored course of classics and mathematics. Then came the scientific school, to be looked upon by the academic department as unworthy of its equal recognition and degree. But the pressing necessities of practical life forced many collegians to go through the scientific school as a post-graduate course, and the university to give equal honors to every department of the institution. It is only within our own generation that the perfection of the old education for all the requirements of life has been questioned. The old education simply trained the mind. The new trains the mind, the muscles and the senses. The old education gave the intellect a vast mass of information useful in the library and useless in the shop. The superiority of the college graduate over the boy from the common school, in the counting-room or the mill, was in his disciplined mind and confirmed habits of work. The superiority of the graduate of the technological institute is that he has passed the apprentice period and learned more than the apprentice could ever know.

Competition is the law of our age, and the survival of the fittest its fruits. Not only are individuals and corporations subject to its power, but cities, states and nations. A line in a tariff-bill in one country throws out of employment and reduces to pauperism tens of thousands in another. New machinery or greater skill transfers the market for some product from one place to its rival. The rolling-mills of Alabama may put out the fires in Pittsburgh. The cotton-mills of Georgia may stop the spindles in Massachusetts. Cheapness and excellence have become the factors of prosperity, for nations and for towns. Our plain duty is not to waste precious hours in vain regrets for the good old times or wring our hands in helpless horrors over the difficulties of the present. The pace of progress may have been faster than our preparations, but experience has demonstrated that when intelligently met, the new is always better than the old. The man who dies for a principle is a hero, but he who starves rather than abandon the methods which fed his fathers is a fool. It is only a generation since a carpenter could also plan and build a house, and a single workman make a wagon, or a knife, or a shoe, or a watch, or any part of either. Machinery has so multiplied and subdivided labor, and stimulated pro-

duction, that only a part of any manufactured article comes to the individual, and upon that he must show exceptional skill.

The common school has been the foundation upon which we have builded capacity and character, and it has superbly done its work, but now the system requires either to be strengthened, or to be supplemented by institutions like the one whose opening we celebrate. The unsolved problem which gives heartaches to parents, and anxious thought to teachers and preachers, is the constantly increasing class of young men and women who have the rudiments of education, but are trained neither to any trade nor any business.

The strength of our liberty has been that it recognized individuals and not classes. It is still and always must be the pivotal principle of our institutions. It was possible in the earlier period and in sparser settlements to carry the same idea into social and business life. But the inventive genius of the century has radically changed our original conditions. It has proved too strong for capital and trade-organizations combined. It has placed them in antagonism, and it has united them for mutual protection. Invention is the Frankenstein of our industrial life. It is the soulless creation of human genius, and relentlessly pursues its purposes. It inflicts untold misery upon the few, and confers equal benefits on the many. It has destroyed the apprentice system. It has substituted employer and employés for master and apprentice. Where individuals found work and instruction, armies are attending upon numberless sections of complicated machinery. The skilled workman, who has conscientiously learned his part, is suddenly thrown out by a device which renders his tools obsolete. He suffers hardship and privations until he can acquire almost a new trade, or he drops into the crowded ranks of unskilled labor.

Inventive talent can neither be curbed nor banished. The necessities of our commercial success demand its encouragement. The limited express train flies along the rails at sixty miles an hour, but the cool and confident photographer by the roadside utilizes the speed of light, and imprints locomotive and cars as perfectly upon the sensitive film as if they were standing still at the station. So it is our duty to meet the emergency of the hour by calling into play and exercise the latent forces which God has implanted in man to subdue and bend to his will the powers of earth and air.

This splendid Institute of Art, Science and Industry leads the column and points the way. The manual-training school solves the

problem of labor and industrial development. Here will be given instruction in the principles of science, art and mechanics, and their application to the mill and the mine, the factory and the furnace, the shop and the engine. Here the student after he has mastered the principles can learn the details of his specialty, and grasp the intricacies of machinery. In the art department his eyes will be educated and his hands trained by drawing and perspective, by studies in light and shade, by painting in oil and water-color, by theoretical and applied design, decoration and ornament and by architectural and mechanical drawing. But physical methods will be supplemented by thorough instruction in the theory and history of art. In the scientific department the secrets of the laboratory will be revealed, chemistry and applied physics will solve the mysteries of nature, and the wonderful works and properties of electricity will become known. As the boy advances from the elementary course he will receive instruction and become familiar with the workshop and its machinery and tools. He will grow skillful in the handling, manipulation, molding and carving of wood and iron. Work on the bench, with the lathe, the drill, the plane and the screw, and the making of tools will be common and easy, and the student will practically run the boiler and the engine.

The graduates of this school will not be confined within the narrow lines of the apprentice, nor bound by the limitations of the specialist. Upon the broad foundations of their training can be securely built superior capacity for the paths in the industrial world which they elect to follow. They will hail the inventor as their friend, and follow with keen delight his discoveries and improvements. He may render obsolete and useless the tools to which they are accustomed, or the work which they produce, but their thorough grounding in principles will enable them to instantly understand his device, and adapt themselves to the fresh roads they must tread, or retire to the rear. Disciplined intelligence, and harmoniously-cultivated minds and muscles, will give the economy in the use of materials, and skill in handling of tools, which will command the markets at home and abroad, against the output of mills and factories where their brethren vainly strive, under old conditions and training, to keep pace with progress and earn living wages in the fierce strife and heat of modern competition.

It is a remarkable illustration of the failure of the schools to divine and meet the changes of the century, that the first suggestion of a manual-training school came from Victor Della-Vos, Di-

rector of the Imperial Technical School of Moscow, in 1868. The Centennial Exhibition in the city of Philadelphia in 1876 gave to educators in America and Europe an idea of its scope and necessity. The old education had accomplished splendid results during the first hundred years of our Independence. We entered upon our second century by an immediate experiment with the new. After twenty-five years of trial this superb foundation is an enduring monument to its success.

One of the chief glories of the new education is the advantages it gives to women. It recognizes and enforces their equal rights to every intellectual and industrial opportunity which school or college can give to men. It has created for them the Harvard Annex and Barnard, Wells and Vassar, Wellesley and Smith. It has opened the doors of this institution that they may enjoy all its privileges.

It was the disgrace and finally the ruin of Greek civilization that wives were uneducated. Virtue and ignorance, vice and culture, were companions among the women of Athens. America has always been distinguished for the consideration and justice accorded to the gentler sex. And yet it is only within the last half of the present century that a university course upon the same plane as the highest of our college curriculums has been attainable for girls. By following our example and success, ancient Cambridge in England has startled the conservatism of the ages.

The proud ladies who danced the minuet at the inauguration ball of George Washington as first president, never dreamed that modern development might compel their great-granddaughters to enter the lists of labor to earn a living. Our boasted progress has known neither age nor sex. Tender youth and delicate womanhood have been compelled to meet its requirements. It threw upon woman burdens for which she was unprepared. There were only few things for which she was trained, though she was fitted for many. The overcrowding of a limited market has destroyed independence, and has compelled women to accept any pittance which avarice might grant. The tragedies of the needle have filled the ocean with tears and the land with sorrows. But from their splendid colleges our girls have graduated equipped for the better positions and pay of the important chairs in the schools of the country both great and small, and for literature, journalism and art. From the technological and manual-training schools they invade the fields of electrical appliances and mechanical drawing, of

photography and phonography, of architecture and decoration. It is still the reproach of our times that women receive less pay than men for the same work, equally well done. But chivalry is an emotion, not a habit, and sentiment is left at the shop door in the business world. It is through the power they acquire here, and in institutions like this, that women will be able to fight for and win their rights.

This Institution is an object lesson in the proper use of accumulated wealth. No one remembers or cares how Peter Cooper made his money but neither this generation or succeeding ones will forget to be grateful to his memory for the wise provisions and endowments he made for the education of the people. Commodore Vanderbilt's control of and connection with railroads will in time become a tradition which few can recall, but his name will live forever through the university he founded, and which bears his name. mining and transportation companies are already administered by Asa Packer's others than his kin, and his work in their creation and development has passed out of mind and mention, but the college he established and enriched will ever keep fresh and conspicuous his character and deeds.

The Drexel Institute is not a charity. It neither offends the proud nor encourages the pauper. The dangerous crank is the child and victim of competition. This school will give him a full mind and healthy body. It will so equip him and open avenues for his energies that instead of dynamiting the successful, he will be himself a success. It is a practical and beneficent illustration of the Divine injunction, "Thou shalt love thy neighbor as thyself," which extends the helping hand and tenders warm and sympathetic encouragement to the brother who wants to help himself. It is a noble recognition of the needs of the youth of both sexes by placing before them the weapons and the armor for the battle of life, and training them in their uses. It will nurture and instruct a better and broader womanhood, a braver and more intelligent manhood, and a more patriotic citizenship, and as the years increase and graduates multiply, the Republic will be enriched in its material prosperity, and receive new vigor and earnestness in its moral and intellectual life.

THE DECLINE IN RAILROAD BUILDING.

By Thomas L. Greene.

THE extent of railroad building in the United States during 1891 was a little over 4000 miles; the new mileage in British North America was about 450 and in Mexico about 350, in all not quite 5000 miles for the continent. This is a small addition to our mileage judged by former years. In 1890 the construction in the United States amounted to 5700, and in 1889 about the same. During the decade it amounted to nearly 69,000 miles, or an average of about 6900 for each year. To the comparatively smaller number of miles built during the past year, Pennsylvania contributed about 240; Washington, 230; Georgia, South Carolina and West Virginia about 200 each; Montana, Alabama and Virginia something like 190 each; while the States of Tennessee, Texas, Colorado, Louisiana, New York and Ohio report each new building to the extent of 140 to 160 miles. Connecticut, Delaware, Maine, Nevada, Mississippi, Indiana, Kansas, Maryland, Massachusetts, New Hampshire, Rhode Island and Vermont had little or no new mileage. All this new construction was undertaken by a number of companies with an average of about fifteen miles of new road each. Thus the additions were mostly branches or short connecting links.

Not only was the total new mileage in 1891 smaller than in previous years, but there was a shorter average length ascribed to each constructing corporation. This arose from two causes—one financial, the other commercial. The first is owing to the difficulty, dating from the Baring liquidation in London and still obtaining, of selling to the public new bonds or stocks. In this refusal of investors to lend money to railroads, many old companies which had important connections to build and companies with new projects have suffered alike. While railroad companies with high and long-established credit have been able in some cases to sell bonds for work done or in prospect, a number of railroads of undoubted financial soundness have been embarrassed in finishing lines begun or contracted for before the Baring troubles. These latter roads have been obliged to borrow money from banking institutions on demand or time loans, while awaiting the return of public confidence in railroad investment. Though no data exist for accurate statements,

it is estimated that the railroad floating debts of the United States amount to $200,000,000, including in that term only those sums which have been spent for new construction or betterments, and which will be paid by future bond-issues on good roads.

Hence the new mileage of 1891 represents principally such work as was under way previous to the beginning of the year and which could not be stopped without loss, or else such new construction as commended itself most strongly to the old railroads, or to the more daring capitalists—strategic lines we may call them. It is well known that our prominent systems are made up of smaller lines welded together. We cannot say that such systems were the result of foresight, but rather that, like "Topsy," they "growed"; and if this be true it is apparent also that their growth in the future will be limited only by opportunities presented, as these may develop themselves from year to year. Hence it should occasion no surprise to find that energetic directors and managers have the possibility of new lines always in mind practically, even though opposed to overbuilding theoretically. In truth there is no general theory about the matter. The whole is made up of its parts; and in railroad building each part looks to its own needs and does not concern itself about the effect of its action upon the tariffs or the complicated relationship of the general situation.

As illustrating this, let us look at a few of these recently-built or building strategic lines. The Baltimore and Ohio, leasing the Pittsburgh and Western, has just finished a line from Akron, Ohio, west to the junction with its main Chicago road in Ohio. This road is but a few miles in length but it opens another first-class through line between Chicago, Pittsburgh and the East. It brings into Pittsburgh an active competitor with the Pennsylvania Railroad which has hitherto controlled the greater part of the large traffic of that important manufacturing center. The Canadian Pacific is a vigorous company. During the year it has extended its lines in British Columbia and Manitoba, strengthening its local grasp upon those provinces. It owns the important railroad from the Sault Ste. Marie to Minneapolis and St. Paul, a line which from its geographical position "sets the pace" in rates for the older Chicago roads between New England and the Northwest. This line is being extended from Minneapolis through North Dakota toward Canada west of Winnipeg and may in time form a new main line for the Canadian Pacific. The Chicago, Burlington and Quincy, having lines from Chicago and through Nebraska forming a great system,

has built extensions north and west from the Black Hills, North Dakota, toward the Yellowstone National Park and Montana. The Chicago and Northwestern has constructed a number of short roads in Wisconsin and upper Michigan, which, with its recently-purchased Milwaukee, Lake Shore and Western, gives it a strong position in the possible struggle for the ore, lumber and lake traffics of that region. The Pennsylvania Railroad has caused to be built roads to the coal-fields and elsewhere, which, with the lines of the Philadelphia and Reading, gives the first place among the States of Pennsylvania for the amount of new mileage. The Great Northern is now building a new transcontinental line from its old terminus in Montana across the Rocky Mountains to Puget Sound, a great and important enterprise. The Northern Pacific, in anticipation of the coming of competitors, has been building short lines in the State of Washington to the cities and towns occupying important sites. In Virginia, West Virginia and Kentucky new routes have been formed or are forming by the construction of connecting roads. The Louisville and Nashville, besides constructing lines of local interest, has made a connection with the Norfolk and Western at Cumberland Gap, thus opening a western outlet for Virginia coal and an eastern outlet for breadstuffs. The Norfolk and Western is also finishing a line northwards across the Ohio River which will give it access to Ohio and Illinois trade and allow of a great increase in the output and carriage of its coal. The Missouri Pacific, by building seventy-three miles in Louisiana from its line in Arkansas to the Texas and Pacific, has made possible the shipment and export through New Orleans of a share of the grain of Kansas and Nebraska which now seeks the Atlantic sea-board. These few miles may affect the railroad situation over a large area. A projected line of 153 miles under the Wabash system from near Detroit to Chicago will strengthen the strategic position of that company. The lines reported built or projected in Alabama, Georgia, South Carolina and other Southern States are partly accounted for by local requirements and partly by the fear of the larger companies that territory near these lines if left unoccupied would invite undesired rivalry. The small new mileage in New England was principally for local needs and that in New York State was largely "manœuvring for position."

It will not escape attention after this rapid survey that the new mileage was almost wholly built by existing corporations; and that the new enterprises strictly so-called, that is those which were

begun independently of the large systems, formed but a small fraction of the whole. When to this is added the further fact that our older but smaller roads are slowly being absorbed into the large systems, it is apparent that railroad building and operating is falling into the hands of huge and powerful corporations. Since the same tendency is observable in different degrees in all kinds of business, it is fair to suppose that the Interstate Commerce Law is not alone responsible for it, though no doubt the act to regulate commerce accentuated the impelling forces and so hastened the process. One of the results of this consolidation is the growth of the idea that an existing railroad has vested rights. Though as yet rather vaguely held, this theory about the moral wrong of building parallel roads has weight. When presented to him boldly, that is when he is asked to furnish money to build a road which promises profit though at the expense of a line already established, a banker will hesitate and probably refuse financial aid. The Chesapeake and Ohio, to take an illustration, considered itself entitled to run its trains in and out of Washington City. Rather than compel the construction of another line, the Virginia Midland entered into a contract giving to the other its asked-for trackage rights to the National capital. In the suit of the Rock Island and St. Paul roads to force the Union Pacific into a fulfillment of its contract and so allow trains of the complaining roads to cross the Omaha bridge, the judge added to his legal decision the economic plea that paralleling of bridges and railways should be discouraged, even by the courts, whenever possible. The building of the Burlington road into Deadwood, South Dakota, where there was supposed to be traffic enough for but one road, was resented by the Chicago and Northwestern, the first on the ground, as a breach of unwritten railroad law.

Consolidation of our railroads into systems, and the consequent growth of a sort of code of railroad morals between the great companies, will not, however, stop railroad building. The great and essential difference between European and American conditions is that there railroads were built to accommodate existing traffic ; in the United States they are built principally to create trade. An average community here furnishes to a railroad about four times the traffic which a similar community in Germany gives. Abroad in old countries, simple manufacturing was early established to supply the surrounding country, and thus German towns had their supplies near at hand. When railroads were built they found trade already

moving in small circles, nor have they been able wholly to overcome this economic situation. On the contrary the early American railroads were pioneers ; they carried clothing and shoes from the settled parts of the country to the prairies and brought back the settlers' grain and cattle. This wide exchange has continued even after the growth of powerful inland States and cities. Exactly this reasoning still holds good. The Great Northern, for example, building 2000 miles of line through an unsettled country, will, by the opportunities offered to immigrants, in time create its own local traffic, a traffic which without that line would not exist. In a more restricted sense this is true too of the older States. A competing railroad is constructed into a town to the disgust of the road already there, but after a time of confusion and rivalry it becomes apparent that the impetus given to trade by the competition has resulted in such an increase that both roads are benefited.

To follow this question a little further, let us take the case of wheat growing and shipping. It is assumed by certain magazine writers that our wheat production has reached its limit ; that we may indeed import wheat from cheaper India or South America. This contention does not consider the whole question. The wheat acreage of the United States could be doubled at once if required, from land now uncultivated or used for other crops. Nor ought we to say that we have reached the limit of cheap production as against the poorly-paid but really dear labor of Asia or South America. It is not a question of productiveness or limit of wheat-land, but one of price or rather of profit. Farmers will continue to grow wheat (or even to increase the acreage) and the railroads to carry it to the ocean for export, if the profits of the crop are not turned to absolute loss. Again, every mile of new road, especially west of the Mississippi, opens up more grain-fields. Irrigation will sooner or later also increase the supply. What indeed can a settler do but plant wheat or corn ? It is idle to tell him to diversify his crops. Thus the assumption is that the roads between the seaboard and the Mississippi River, so far from losing their grain and other traffic, will probably gradually increase it, though with fluctuations. And when financial conditions change and there is again a widespread "boom," railroad men with this prospect of increasing traffic in mind are agreed in expecting a fever of railroad building, in the East as well as in the West, which will make up by its violence for the comparative quiet of the last few years.

Railroad building implies the expenditure of capital. In the

long run the investing public decides the matter, for without the confidence of moneyed men our railroad extensions cannot be built. It has long been considered that railroad bonds and stocks afforded by far the best investments into which the ordinary capitalist could put his money. Real-estate mortgages demand special care and are limited both in number and amount. The so-called industrial or commercial stocks of manufacturing and trading corporations are not as yet sufficiently tried in the United States; while the business of transportation is considered to be the best for the investment of large capital. Nevertheless it is a fact that large losses have been made in railroads and that there is, at least at present, hesitation and distrust on the part of the investing public.

Aside from the efforts of legislatures to reduce railroad tariffs and the indirect though even more powerful results of such acts as the anti-pooling clause of the Interstate Commerce Law, there is a constant commercial pressure toward lower rates, just as there is a pressure upon farmers toward lower prices on exports. Mechanical improvements, such as the increase in the capacity of locomotives and cars, have about reached their limits; we cannot expect another such invention as the Bessemer steel rail, though we may rightly look for further economies when the air-brake shall double the number of freight-trains which can safely and rapidly be moved daily over a given road. On the whole our best hope for a reduction in expense—and therefore in the possible charge—seems to lie in the consolidation of short lines into a system and an increase of the traffic of that system by further extensions; and this has been going on. Under further possible tariff-reductions, under growing demands for better service, under increasing murmurs against grade-crossings and similar evidences of cheap construction—under all these, where is the railroad bond-interest and dividend to come from? It must be acknowledged by any one who studies the subject, that now, whatever may have been formerly the case, the railroads need protection against unjustly-low charges rather than the public against exorbitant tariffs. And since enterprises of all kinds are adjusted in the long run to profits, unreasonably-low rates certainly will bring about unreasonably-poor service. Still, profit can be made from a large volume of traffic carried long distances at low charges as well as from a small business at high prices, provided the volume is large enough; and in any case the commercial questions of tariffs and profits will set-

tle themselves best where laws do not interfere with the solution either on one side or the other.

It must be acknowledged, too, that we have complicated the subject of railroad building and the consequent investment and returns of capital, by not setting forth all the facts in our railroad reports. Particularly where we ask for foreign capital to help us build new railroads, we do not put emphasis enough upon the fluctuating conditions of business in the United States. We say too much about the large earnings at times and not enough about a possible decrease ; too much about profits and not enough about stability—for the railroad traffic of America is stable, it is true, but within wider limits than obtains abroad. From the nature of our conditions all business in the United States is more speculative than in Europe—using the word in its good sense. We must and we do discount the future. There are many enterprises in the United States which are based upon sound principles, and yet which may not at once fulfil expectations. Now the proper way to treat railroad earnings under such circumstances is to reserve for the road a fair proportion of the profits in good years, that the poor years may not find it entirely unprepared. The contrary is often the course pursued. Sometimes, to gratify English holders who wish rigid English accounting-methods applied to American railroads in spite of the differing conditions, sometimes to put up values in the stock exchanges, the managers of a railroad will unwisely distribute all the earnings or perhaps render dishonest and false reports. If in the next year the decreases in traffic should be serious, the investor suffers loss ; so by the great and needless fluctuations the legitimate and—under reasonable conditions—safe construction of needed railroads is discredited.

Such a period of distrust we are now passing through. American railroad securities and Argentine cedulas are in Europe alike under suspicion, but there is no connection between the two. It is proper to take the opportunity during the pause to say that railroad extensions, when warranted commercially, are worthy of approval and worthy also of financial support, though the argument for them should be sustained conservatively and through the application of good business principles.

THE GOLD-FIELDS OF SOUTH AFRICA—I.

By Gustave Hallé, Asso. Mem. Inst. C. E.

THE late rise into prominence of the great gold-producing regions of South Africa is fraught with a complexity of interest to the general public as well as to the specialist, to which the discoveries of the precious metal in either America or Australia yield no parallel. The American mining-districts, whether in the northern or southern hemispheres, are looked on rightly as more than the realization of the middle-age legends of the El Dorado of the early European buccaneers and navigators. But the South African gold-fields claim, and, since the investigations of Mr. Theodore Bent on the ruins of Zimbabye, Tuli and elsewhere, appear to claim rightly, to be the biblical land of Ophir itself ; probably in the regions round Sofala and the river Sabia, on the eastern coast, to perpetuate the very name of the realms of the Queen of Sheba. Without going into the question of the accuracy of the amount of gold stated to have been drawn from Ophir by King Solomon (some estimate it at nine hundred millions present British currency) or the reliability of the description of the mineral wealth of Africa given by Herodotus, it is undeniable that a series of authors, commencing with Josephus, who distinctly identifies this Sabia with the golden Ophir, and continuing through the Mahommedan, Abyssinian and Jewish writers, to Lopez, De Faria and the old Portuguese chroniclers of the fifteenth and sixteenth centuries, and so on to Bruce, Ogilby, and the later European travellers of the last hundred years, we have a mass of legendary, as well as of more or less historical, authority as to the vast mineral resources of Southeastern Africa, which renders the commencement of its actual practical development during these latter years a matter of quite singular interest and curiosity.

Whether Milton, himself no mean authority, was correct in following the Septuagint interpreters in translating Ophir into Sophira, hence to Sofala and quoting—

> "Mombaza, Quiloa, and Melind
> And Sofala (thought Ophir) to the realm of Congo, and Angola farthest South"—

it is at all events indisputable that at the close of the sixteenth century the Portuguese had established a government in the so-

called Empire of Monomotapa, a region extending roughly from the Zambesi to present Tongaland, from which empire they are stated, according to records at Lisbon, to have drawn gold to the amount of two million quintals (roughly £1,000,000). What is certain also is that, besides the singular and wide-spread ruins lately investigated by Mr. Bent, the well-known archæologist, at the request of the British South African Chartered Company, and pronounced by him to be undoubtedly relics of a gold-working people, probably Phallic worshippers of Phœnician origin, the whole region has scattered over it ancient workings of an extent almost incredible. The present writer has himself examined shafts, adits, and trenches on gold and copper lodes in Swaziland, and near the Moodie gold-fields, utterly beyond the capabilities of the native as he now exists, choked, in instances by dead trees, in sites the date of whose decay even it was impossible to estimate. In similar workings in the Middelburg district, shafts, sunk lately in the fallen-in debris of a gigantic open cutting, have come across iron picks and gads of excellent workmanship, but of form distinctly varying from any known European types. Three hours west of Pretoria, again, the writer has traced for a distance of from three to five miles a continuous series of trenches and shafts, which, from the spoil and débris accompanying them, must represent a depth far greater than that now accessible. In Zoutspansberg, and across the Limpopo, regularly-laid-out mines, in some instances with drives hastily blocked up, and telling a tale of sudden surprise and violence at the hands of neighboring warlike tribes, have been found with regularly-squared-up heaps of ore, lying alongside well-made roads, still waiting measurement.

The more modern traveller, of the last thirty to forty years, has, with singular persistence, dwelt not only upon his verification of the descriptions of his early predecessors, but on his own actual discoveries, in confirmation of the existence of gold and other minerals over the whole of the district of their labors. Lichtenstein, Livingstone, Cumming, Mauch, Erskine, Elton, Chapman and Baines are but few among those who have borne testimony to the presence of gold practically, more or less, over the whole of the Transvaal and Matabeleland. The present epoch of practical mining has so far corroborated the whole of these statements to an extent that promises to cap their most high-flown descriptions as fully as the achievements of the present American mining-industry have out-Heroded the wildest fables of El Dorado.

Taking the above as the antecedent legend or pre-historic story of the South African mineral districts, and recognizing them as being both abundant in romantic and specific interest, and full of promise of an actuality of practical results worthy of the immenseness of this vast continent, one may place the date of the commencement of the present great development somewhere about the year 1854. Taking the birth of North American mining at about 1849, the unbiased historian will be struck in the first place by the divergence of circumstance that has resulted, in the case of America, in the arrival of a state of decline of the gold-mining industry, at a date, the present, at which the African industry is, apparently, just entering on an epoch of most vigorous expansion. In the year 1845 Leopold von Buch, the great German geologist, had pronounced on the similarity of the geological formation and metalliferous strata of South Africa and Australia, but it was first in 1854 that, owing to the actual discovery of gold at Potchefström, in the neighborhood of the present Rand gold-fields, and at Smithfield, in the Orange Free State, the first prospecting parties made their appearance in South Africa. Through ignorance of method, lack of capital, and topographical difficulties, however, this preliminary burst of energy subsided as suddenly as it had arisen ; and interest, and in fact belief, in the mineral resources of the continent survived principally in the brain of a few enthusiasts encouraged by an occasional discovery, or the intermittent reports of up-country travellers.

Towards the year 1865 matters grew slightly more definite. Mr. Hartley, a well-known elephant-hunter, while in Matabeleland, came across some of the ancient workings of the legends—now, by the way, being opened up under the Chartered Company—and took up a geologist, Carl Mauch, with him on his next trip. Mauch located a gold-field, eighty miles by three in dimensions, in Matabeleland. Several new prospecting companies were at once formed in the Cape Colony and Natal, and after a varying amount of ill success, a small mining-camp established itself at the Tati fields, a triangular district of sides respectively eighty-five, eighty and sixty miles in length, lying about 21° 27′ S., and 27° 51′ E. Between 1866 and 1872 from 1500 to 2000 ounces had been won from here. Owing probably to the distance from the coast, nine hundred miles from Durban, and one thousand from Port Elizabeth, together with the narrowness of the reefs, these fields never reached any notable prominence ; the larger number of the few miners there left on the

NATIVE LABOR IN TRANSVAAL GOLD-FIELDS.

NATIVES BAGGING GOLD QUARTZ, LYDENBERG.

discovery of diamonds at Kimberley, and the Tati district since then has had a more or less spasmodic existence under a concession granted by the local chief to Sir John Swinburne, one of the earlier encouragers of its first development. The gold in the Tati occurs chiefly in narrow, probably gob, veins in granite. It is often certainly of great richness, reaching occasionally to 50 ounces to the ton, picked specimens going as high as 1500 ounces; 226 ounces have been obtained from 74 tons.

Simultaneously with this, Mr. Thomas Baines explored Mashonaland, examined between 1868 and 1870 numerous old workings, found a quantity of reefs, running from ½ to 3 ounces per ton, and succeeded in obtaining in the latter year a concession from King Lobengula, to explore and mine for minerals over the greater part of Matabeleland. This incident is chiefly interesting as foreshadowing the grant on which the present British Chartered Company has been founded. The region covered by these concessions is more than half as big as Europe. It is also curious that the grant to Baines was disputed by the Portuguese governor of Guilimane on the ground of Portuguese sovereignty over the whole of the land north of the Limpopo, a claim as sturdily resisted by Baines on the plea of want of proof, as later by the British Government.

It is remarkable that these preliminary prospectors should have

chosen Mashonaland, the country of the unconquered and warlike Matabele as the first field of their labors, and that the opening up of the Transvaal should only have been commenced with later.

Whether it was from the existence of gold in Mashonaland being, as rumor made it, richer than in the more southerly and more accessible Transvaal, or that the totally uncivilized native seemed an easier person to deal with than the semi-civilized Boer, is impossible to say. The present labors of the Chartered Company should shortly elucidate the claims of Mashonaland as an actual gold-field; and the Boer, prior to 1870, was certainly a very difficult person to deal with. An American who reported in 1860 that he had discovered gold in the Rand district was promptly ordered to either pay £500 fine or leave the country. A general measure was passed later that any one finding precious metals, or any stones of value, calculated to bring the English into the country, must conceal the locality of his find under penalty of 600 rix dollars. In fact the character of this nation may be guessed at from the fact that, on the first declaration of their independence in 1852, one of their preliminary acts was to repeal a former measure fixing the boundary of the Transvaal at the 25° S. latitude "because the Volksraad has no means of ascertaining where the said degree of latitude may be"!

MINING COMMISSIONER AND PROSPECTING PARTY LOCATING CLAIMS, LYDENBERG DISTRICT.

The utter inaccessibility, in those days,of Mashonaland is in itself, however, sufficient to account for the practical collapse of these second preliminary attempts.

The present era of South African mining really begins with the practical discovery of payable alluvial gold near Lydenberg, latitude 25° 6′ S., longitude 31° 30′ E., in the eastern portion of the Transvaal by Mr. E. Button, a Natal Colonist, in 1869. Button, an Australian called Sutherland, M'Lachlan and others, found gold at the Silati, in Zoutspansberg, at the Murchison range on the Libombo, at Ersteling, Marabastad, and other places, in all which their finds have been more or less verified since. By 1871 parties of diggers were at work in diverse of these localities. At Ersteling, the alluvial extended about three miles down a spruit or rivulet the deposit being somewhat thin, and by no means rich. Small veins of ferruginous quartz were also found, running extremely high in gold ; in cases up to 150 ounces to the ton. The number of alluvial diggers, however, here and at Marabastad, never perhaps exceeded one hundred. Batteries of five to twelve stamps have since been put up at the veins, and have so far, notably in the case of the Mount Maré Company, held their own with moderate success.

Work, both on alluvial and veins, continued to spread in a more or less desultory manner all over the eastern portion of the Transvaal. New localities such as Mac Mac, Pilgrim's Rest, Kendriksdaal, Spitzkop, Waterfall and Origstadt, were opened up, till by 1873, a district fifty miles by eight was supporting upwards of one thousand diggers with their accompanying providers. Dr. Petermann in his "Mitteilungen," 1879, estimates the yield from the South African fields from 1866 to 1870 at £23,000 ; in 1873 at £103,416 ; in 1874 at £250,766 and 1875 at £185,726. Nuggets of 10 ounces, 16½, 22¾, 20, 30, 48, 96 and 180 ounces were found during 1873. One party of three men at Pilgrim's Rest found 216 ounces in one day ; men were known who averaged 1½ ounce per man per day for over one hundred days at a time, and it is indubitable that for a considerable period a large population was maintained by legitimate alluvial digging, the true returns of which were immeasurably higher than those published. The reef gold found at Lydenberg occurs in horizontal beds interstratified with clay shales ; these beds are for the most part composed of more or less rotten quartz and iron oxides, and therefore quite soft. The "alluvial" is in general found in decomposed greenstone dykes, and is the result of the liberating of the gold previously contained in the secondary quartz,

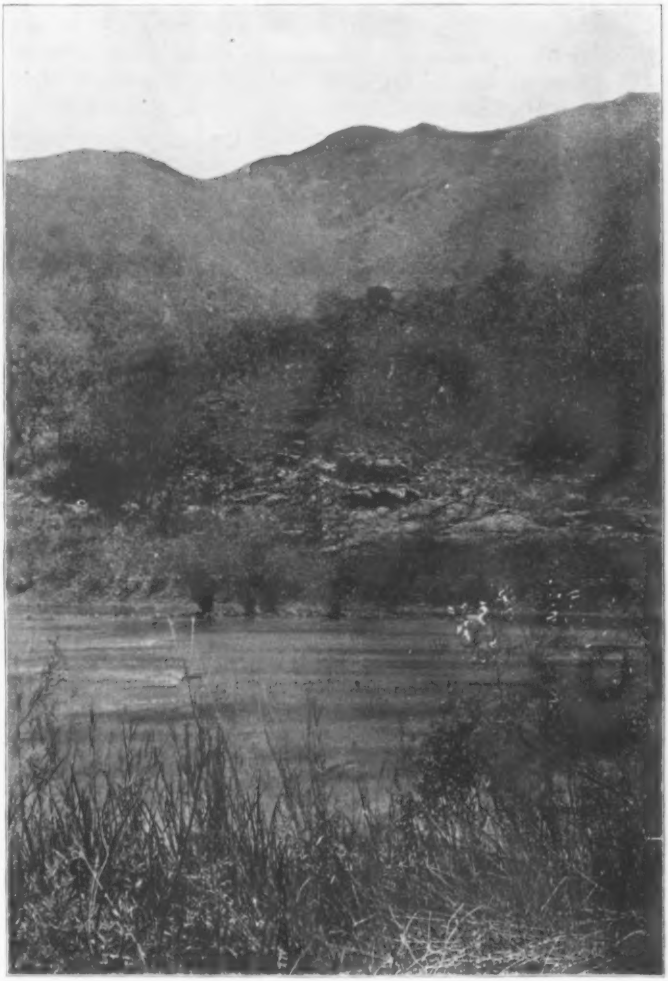
A NATIVE ROAD PARTY, TRANSVAAL.

which filled fissures formed presumably by contraction on cooling, in that rock. A certain proportion has also found its way by gravitation into the creek-beds where of course it is true alluvial. All this gold is crystalline and not water-worn in any way, evidently showing that it has been formed *in situ*. Furthermore, large sheets, but of no great thickness, are found frequently in the quartz beds, and in fact the mode of occurrence is so far as we know unique. The whole district is proverbially so rich that when a child in Lydenberg asks its father for 6d. it is supposed usually to meet with the answer "take a pan and wash it from the spruit," or town ditch. South African mining had in fact been at last fairly started on the basis of a good alluvial district when the greed of a few men and the shortsightedness, combined with the corruptibility, of the Government gave it the first of the many blows it has suffered at the hands of the unscrupulous speculator. Tempted by the increasing richness of the declared returns, certain influential persons applied for and obtained from the Executive, concessions over whole tracts of these Lydenberg fields, dividing in fact the entire district between them. The alluvial diggers were turned off after a struggle, requiring the presence and threatened employment of armed commanders of burghers. A number of companies, the Lisbon-Berlyn, Transvaal Gold and Exploration, Graskop, Spitzkop, Moss Hill and others, were floated in England with quite exceptional flourishes of prospects. These, it may be reported with somewhat cynical satisfaction, have in almost every instance failed to pay. Where the individual digger could largely reap success, the heavily-capitalized company, representing as it did the successful and unsuccessful digger equally, found the loss of the one to balance the gain of the other, and the district is anything but savory to the European investing speculator. The policy of the Boer Government has been throughout to extract as much revenue as possible out of the mineral wealth of the country by means of the most limited mining-(and therefore foreign) population that could be contrived, the consequences of this unnatural method being, as might be expected, a series of checks to the healthy expansion of the industry that nothing but the intrinsic value of the mineral resources of the country could have successfully combatted. Certain companies in the Lydenberg district are certainly still extant: the Transvaal Gold and Exploration Company doing at present well, though from veins and not alluvial, and testifying, in spite of the general mismanagement of the district, to its innate richness.

UP-COUNTRY BATTERY, EASTERN TRANSVAAL.

A SOUTH AFRICAN MANAGER'S HOMESTEAD.

With the forced collapse of the Lydenberg alluvial diggings the first chapter of the history of South African mining may be taken to have closed. The second might be appropriately headed Moodie's and the Kantoor. The progress of mining in South Africa, as in fact the progress of civilization itself in this half continent, has had, as has been hinted at, political factors and events to deal with, which require to be constantly borne in mind in endeavoring to arrive at a true appreciation of the importance of each sudden development, and each apparent pause. The chief of these factors are the Boer and the Black; their influence, the wars and other troubles which their existence in a strong majority inevitably entails. Neither in America nor Australia has the native been sufficiently to the fore at the rise of the mining-industry to appreciably impede it. A foreign element, and that one in reality established in possession of the country and regarding himself as put there by the special design of the Almighty, has existed in neither continent. The South African Boer is an individual possessing all the sturdiness of the toughest type of European, the Dutch, and imbued with the culture of four centuries back, modified by a residence in the wilds since that period, the date of his immigration. The presence of these two factors, as elements of passive and occasionally active resistance to progress, is a circumstance that can only be fully appreciated after a lengthened sojourn in this continent.



SCENERY IN THE LYDENBERG DISTRICT.

They give, it is true, a tone of interest and romance to the development of the country, as for instance in the story of the Matabele and Swaziland concessions, and the Boer, Sikukuni and Zulu

wars, etc., but are necessarily fatal to any continuity, or true economy of progress.

The period, for instance, between the close of the alluvial period at Lydenberg in 1875, and the new rush at the Duivel's Kantoor (Devil's counting-house) and Moodie's in 1882, was almost entirely filled by the Sikukuni war of 1876, and the Boer war of 1880. With these wars all digging or prospecting in these eastern portions of the Transvaal came to an abrupt close, and South African mining was again restricted to the copper of Namaqualand on the west coast, and the great diamond industry of Griqualand West and the Orange Free State. Diggers in the Transvaal were given forty-eight hours to choose between being "commandeered with horse, saddle and rifle," as the Boer requisition runs, or leaving the country. The choice was hardly doubtful between the dangers and privations of a desultory war against a race of natives, who, though lacking the cunning and ferocity of the Red Indian, are as savage in warfare as they are good-natured and friendly in peace, and the allurements of that most unique of all mining-districts, Kimberley, a district then entering on its second and most brilliant period of prosperity, a period resulting in a declared output of the value of £4,000,000 sterling from some of these pits, each of a few acres in extent.

There was an almost general exodus from the eastern Transvaal of the mining population in 1875. The following lustrum included episodes as curious as the inauguration of a war by the Boers against the most powerful of the chiefs included within the nominal boundaries of the Transvaal, their defeat by this same Sikukuni, their piteous appeal to the British Government for protection from destruction; the defeat of Sikukuni by the British troops, with a Swazi army as allies; the re-establishment by the British of the Boer Republic, its financial collapse and annexation in 1878; the revolt of the Boers in 1880 against the Government which had twice saved them from the Zulus and from Sikukuni; and finally the second re-establishment of Boer independence after the retirement of the Gladstonian Government from a struggle in which the European methods of attack in close column had been disastrously unsuccessful against a numerically smaller force of sharpshooters advantageously posted. During this period of crowded incident, in itself worthy of many a chapter of description and comment, the mining development of the Transvaal lay dormant. It was destined, however, in 1882 to surge onward again in

two movements, the Kantoor and Moodie "rushes," the story of whose chequered successes fitly paved the way for the greater incidents of the Barberton and Witwatersrand fields, the latter of which has already raised South Africa to the position of having produced more gold from a smaller area in a given time than any other gold district in the world. The output namely from these fields, a district thirty miles in length by barely half a mile in breadth, or fifteen square miles, has been, for the past month, October, 1891, 72,793 ounces!

The history, however, of this extraordinary development from 1882–1891 must be reserved for a further article.

THE KOMATIE RIVER, EASTERN TRANSVAAL.

THE WIND AS A FACTOR IN GEOLOGY.

By George P. Merrill,

United States National Museum.

THE importance of the wind as an abrading and transporting agent is appreciated fully by the majority of geologists. In the paper here presented, the writer has aimed to note some of the more interesting and striking results thus produced, with a view, however, of furnishing entertainment and instruction to the general public, rather than of offering it as a contribution to geological science. One of the safest and surest methods of gaining an insight into the efficacy of various geological agencies acting throughout the past history of the globe is to study in detail the effects of these same agencies as they have been observed to operate during the comparatively momentary period of human history. Thus, to appreciate what the wind has done in the past, it will be well to consider first what it is doing and has done in our day.

That the moving currents of air have the power of lifting and transporting solid particles, varying in size and weight with the strength of the currents, must be evident to every one. The clouds of dust whirled fiercely down the streets, the advance-guards of our afternoon thunder-showers, are disagreeable illustrations of what the wind can do when once it sets about it. In the eastern and northern parts of the United States, however, where an abundant rain-fall covers the ground with a blanket of sod or mantle of forest, one can gain but a limited idea of the capabilities of the wind in molding the surface of the continent.

It is stated, I believe by Darwin, that for several months of the year large quantities of dust are blown from the northwestern shores of Africa into the Atlantic over a space some 1600 miles in width and for a distance of from 300 to 600 and even 1000 miles from the coast. During a stay of three weeks at St. Jago in the Cape Verde archipelago this authority found the atmosphere almost always hazy from the extremely fine dust coming from Africa and falling upon the land and water. So abundant was this dust that at a distance of between 300 and 400 miles from the coast the water was colored by it distinctly. In the arid lands of Central Asia the

FOREST ONCE BURIED BY DRIFTED SAND, EXPOSED BY EOLIAN EROSION.

[High part of South Manitou Island, Lake Michigan.]

VOLCANIC ROCKS COVERED BY WIND-BLOWN SAND, MONO VALLEY, CALIFORNIA.
(From a Photograph by I. C. Russell, U. S. Geological Survey.)

air is reported as often laden with fine detritus which drifts like snow around conspicuous objects and tends to bury them in a dust-drift. Even when there is no apparent wind the air is described as often thick with fine dust, and a yellow sediment covers everything. In Khotan this dust sometimes so obscures the sun that at midday one cannot see to read fine print without the aid of a lamp. The tales of the overwhelming of travellers by sand-storms in the great desert of Sahara are familiar to every school-boy. Greatly exaggerated though these may be, the accounts of Layard and of Loftus show us that the sand-storms which are of frequent occurrence during the early part of summer throughout Mesopotamia, Babylonia and Susiana are of no insignificant proportions. During the progress of the excavations at Nimroud, Layard states that whirlwinds of short duration but almost inconceivable violence would suddenly arise and sweep across the face of the country, carrying along with them clouds of dust and sand. Almost utter darkness prevailed during their passage, and nothing could resist their force. It was during one of these storms that the steamer *Tigris* was wrecked in the Euphrates. The air was so darkened that although within a short distance of the shore several persons were drowned from being unable to determine in which direction to swim.

We need not confine ourselves wholly to the old world for illus-

trations. Not longer ago than in May, 1889, a dry southwesterly wind which for several days had prevailed in Dakota and other parts of the Northwest culminated in a storm peculiarly suggestive from a geologic standpoint. It is stated* that during the prevalence of this wind the air became filled with flying particles caught up from the plowed fields, fire-blackened prairies, public roads and sandy plains. The particles formed dense clouds and rendered it as impossible to withstand the blast as it is to resist the blizzard which carries snow in winter over the same region. The soil to a depth of four or five inches in some places was torn up and scattered in all directions. Drifts of sand were formed in favorable places several feet deep, packed precisely as snow-drifts are packed by a blizzard. It seemed as if great sheets of dust and dirt were blown recklessly in mid-air, and when the wind died down at intervals for a few moments, the dirt, fine and white, appeared to lie in layers in the atmosphere, clouding the sun and hiding it from sight for an hour or more at a time.

Over the wide, dry, and bare flat-topped terraces of the upper Madison valley the wind sweeps in a strong, steady current for days together, or during the heated portion of the year, when the sun pours from a cloudless sky its hottest rays upon the parched

SAND DUNES, SLEEPING-BEAR BLUFF, LAKE MICHIGAN.
[From a Photograph by I. C. Russell, U. S. Geological Survey.]

* American Geologist, June, 1889, p. 398.

soil, starts up spasmodically here and there in the form of small whirlwinds made visible by the dust they carry, and which wander specter-like across the plain to disappear noiselessly in the distant mid-air. Riding his patient pony across these monotonously bare, lifeless, and seemingly endless levels, one may not infrequently see these hollow columns of whirling dust from away across the valley bearing down upon him like spectral highwaymen to demand that he stand and deliver. Almost instinctively one pulls up, and stretching his weary legs in the stirrups awaits their approach. Observe the largest one, perhaps scarce more than thirty feet in diameter. On it comes with a steady rush like that of a locomo-

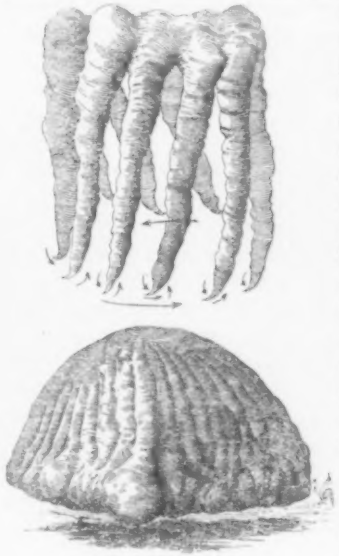
BED OF WIND-DRIFTED VOLCANIC DUST, REESE CREEK, MONTANA.

(From the height of the man's shoulder to his feet the bed is of pure glassy dust so fine and light that when thrown into the air it floats away at the slightest breath.)

tive. As it nears us its rush and whirl have a sound like that of an army of locusts. Its outline is as plainly marked as though confined in a cylinder of glass. Beyond it and all about it is a dead calm—not a blade of grass or particle of dust is disturbed. Immediately within its circumference all is turmoil. Every loose particle of sand, leaf, twig or straw, the offspring of a stingy soil, is suddenly caught up, sent whirling spasmodically about near the surface, ever drawn nearer and nearer to the center and then shot spirally upward with an energy that defies description. Even as we watch it the whirling column cuts defiantly across our path and goes singing off into the distance, for it may be a mile or more, where it vanishes suddenly. Such dust columns are common in all arid regions, and doubtless have been observed by the many who

have crossed the Humboldt desert in Nevada. Seated comfortably in a Pullman car one may see at a single view not less than half a dozen of these geological specters, each in the distance doing its apportioned task and silently disappearing, laying down its load of sand as its strength gives out and leaving it for its successor.

The effect of such frequent-recurring whirlwinds or more constant currents is for the time being slight, geologically, but none the less interesting. In certain regions, as in the Madison valley above referred to, or in parts of the Colorado desert as described by W. P. Blake as long ago as 1853, all the fine, loose sand is blown away, leaving every pebble and large boulder standing out in strong relief. The loose material thus blown along not infrequently gathers in the form of drifts, or dunes, which themselves travel slowly across the country, ever changing their outlines like drifts of snow. A few miles north of Winnemucca Lake, in Western Nevada, is a belt of these drifting sand-hills described by the geologist Russell* as some seventy-five feet in thickness and about forty miles in length by eight miles in breadth. These, under the restless goading of the winds, are constantly varying in shape and in more than one instance have made necessary the splicing of telegraph-poles to prevent the burial of the wires. Another range of sand dunes at least twenty miles in length and forming hills 200 to 300 feet high occurs on the eastern end of Alkali Lake in the same State. On the eastern shore of Lake Michigan are also dunes of sometimes 200 feet in height and which at Grand Haven and Sleeping Bear have drifted over the adjacent woodlands leaving only the dead tops of trees exposed. Similar dunes occur fre-



WIRLWINDS OF DUST.
[After Reclus.]

* Quaternary History of Lake Lahonton, Nevada.

quently on the Atlantic coast, as at Hatteras, on Long Island and Cape Cod. A more desolate region than any of the above was described by Dr. F. V. Hayden several years ago as occurring in northern Nebraska. Here, over an area extending on both sides the Niobrara River and comprising some 20,000 square miles, are only rounded and dome-shaped hills of shifting sand, with but a scanty supply of vegetation and intervening shallow lakes.

Here again we draw a part of our illustrations from abroad. The island of Bermuda is made up altogether of coral and shell fragments. These are washed by the waves upon the beach, dried by the winds, and blown gradually inland, thus forming hills in some cases, as stated by Professor Rice,* not less than 250 feet in height. In other instances, as at Elbow Bay on the south shore of the main island, the sand, like a huge glacier, has quite filled a valley, and still progressing, in a mass some twenty-five feet in thickness, is covering houses, gardens and even woodlands, leaving as at Lake Michigan only the trunks of dead trees standing partially exposed in the midst of sandy plains.

One of the most interesting and remarkable of the many regions for the observation of sand dunes lies between Bordeaux and Bayonne in Gascony, and has been described admirably by Reclus.† The sea here throws every year upon the beach along a line a hundred miles in length some 5,000,000 cubic yards of sand. The prevailing westerly winds continually picking up the surface particles from the seaward side, whirl them over to the inland slope where they are again deposited, and the entire ridge by this means alone moves gradually inland. In the course of years there have thus been formed a complex series of dunes all approximately parallel with the coast and with one another, and of all altitudes up to 250 feet. These are marching steadily inward, though at the rate of but from three to six feet annually, and whole villages have more than once been torn down to prevent burial, and rebuilt at a distance to be again removed within 200 years.‡

The rate of motion of a dune from necessity is governed by the strength and constancy of the winds, and the fineness and dryness of the sand. Urged into temporary activity each little grain goes scurrying up the slope, across the crest, and tumbles to rest in the

* Geology of Bermuda. Bulletin U. S. National Museum.

† "The Earth, Atmosphere and Life."

‡ The Church of Lege, owing to the encroachment of the sand dunes, was torn down in 1690 and rebuilt at a distance of two and a half miles from its first site. By 1850 the dunes had traversed the intervening space and again necessitated its removal.

steeper declivity upon the leeward side to be slowly buried by those which follow. This is the sum total of the movement taking place in the march of a dune, whatever its pace or size. Yet in this very faculty of moving itself forward by but a ten-billionth part of its bulk at a time lies the whole secret of its power. Silently, imperceptibly it may be except when measured by months and perhaps years of time, retarded by no walls nor ordinary declivities, it relentlessly perform its task.

A recent writer in a popular magazine estimates the dunes of Hatteras and Henlopen as in some cases upwards of seventy feet in height and moving at least fifty feet a year. Swamps have thus been filled, forests and houses buried, and it is stated that but a few years can elapse before the entire island lying north of Cape Hatteras will be rendered uninhabitable. The sand dunes on the coast of Prussia commenced not over a century ago and already fields and villages have been buried and valuable forests laid waste by them. A tall pine forest covering many hundred acres was destroyed during the brief period intervening between 1804 and 1827. Loftus, writing of Niliyga, an old Arab town a few miles east of the ruins of Babylon, says that in 1848 the sand began to accumulate about it, and in six years the desert within a radius of six miles was covered with little undulating domes, while the ruins of the city were so buried that it is now impossible to trace their original form and extent. A still more striking illustration of the rapidity of these sand accumulations is offered by the same authority in describing the burial customs of some of these ancient people, it being stated that the earthen coffins were merely stacked in layers one on top of another, and left thus to be covered by the fine sand sifted over them by the winds from the desert. Even Nineveh, founded some twenty centuries before Christ and destroyed 1400 years later, became so covered by drifted sands that at the time of the Greek Zenophon (about 400 B. C.) the very site of the once famous city was unknown.

It is not possible always to trace the drifted sands to their various sources. Dunes along the sea-coasts are in nearly if not quite all cases composed of materials thrown up by the waves on the beaches. This is the case with those of Hatteras, Cape Cod, Gascony, Algeria, and Schleswig-Holstein. But the origin of the large inland dunes like those of Nevada is not so clear. It has been suggested that these may have been formed of beach sand driven in by the prevailing westerly winds from the Pacific coast. This is

however a matter of very grave doubt, and it seems more probable, as stated by Mr. I. C. Russell*, that they were derived from the disintegrating granite of the Sierras. They certainly have travelled far, and are not a product of disintegration of rocks in the immediate vicinity.†

I now have to offer an illustration which, although exhibiting the drifting power of the wind on a grander scale than any yet mentioned, is unfortunate in being still a matter of dispute among geologists. I refer to the so-called loess deposits, particularly those of China. This loess consists of a fine homogeneous clayey loam of a yellowish or brownish color, containing just enough lime to give it tenacity and yet allow it to crumble readily in the hand. In China the deposit covers an area of many square miles in beds of varying thickness, and occurs at all elevations up to 5000 or even 8000 feet above sea-level. Its maximum thickness, in northern China, is stated by Richthofen to be 2000 feet. Running water has cut through the pulverulent mass thousands of ravines or cañons with nearly perpendicular walls, sometimes 500 feet in height, into which a swarming population, like sand-swallows, have excavated innumerable caverns which serve as dwellings. All the physical characters of the deposit and its mode of occurrence are, on the eastern hemisphere at least, indicative of the origin ascribed to it by Richthofen. That is to say, it is due to the long continued drifting by wind, of fine dust over areas more or less covered by grassy vegetation.

Although first described as occurring in the valley of the Rhine, loess deposits have since been discovered occupying large areas elsewhere, extending from France eastward through the German and Austro-Hungarian Empires and far up into the Carpathian Mountains. Deposits of so-called loess are abundant in the United States, particularly in the Mississippi valley. Their æolian origin is here however a matter of grave doubt, their position and characteristics being more those of water deposits. If on further study the Richthofen theory should prove correct for these beds also we might readily conceive of their materials as derived from the arid regions of the west during the drouth which immediately followed the glacial period, as has been suggested by Professor Pumpelly.

The tendency of the wind is not in all cases toward forming

* Quaternary History of Lake Lahonton, Nevada.

† The sands covering the Egyptian Sphinx and pyramids are stated to have come mainly from the sea on the north, and not far from the desert, as is popularly supposed.

drifts and ridges, but at times rather to reduce the land to one general level. Thus J. Flinders Petrie* states that near the ancient cemetery of Tell Nebesheh, on the Isthmus of Suez, the surface of the country has been cut down at the rate of four inches a century until some eight feet have been removed from the dry areas and deposited in the intervening depressions, slowly converting the existing lakes into marshes, and the marshes into dry land. An even more rapid change of contours is that described by Dwight† as having taken place on Cape Cod, Massachusetts. The entire country here is composed of sand so susceptible to the drifting action of the wind that it has for years been the custom of the people to sow pines and coarse beach grass to hold it in place. In the instance described by Dwight, however, reckless pasturage had so far destroyed the grass as to lessen its protecting power and under the strong breezes from the open Atlantic it began to drift rapidly. Over an area of about a thousand acres the sand was blown away, to a depth in many places of ten feet.

But the agency of the wind does not end with the work of transporting the sand and dust. Particles of sand drifting along before the wind become themselves agents of abrasion, filing away on every hard object with which they come in contact. As a matter of course this phenomena is most strikingly active in the arid regions, though the results, when looked for, are by no means wanting in the humid east. It is thought by Professor Egleston that the inscriptions on many of the tombstones in the older churchyards of New York City have become illegible by the wearing action of the dust and sand blown against them from the street. There is to be seen in the National Museum, at Washington, a large sheet of plate-glass, once a window in a lighthouse on Cape Cod. During a severe storm of not above forty-eight hours' duration this became on its exposed surface so ground from the impact of grains of sand blown against it, as to be no longer transparent and to necessitate its removal.

Apply now this agency to a geological field in a dry region. The wind sweeping across a country bare of verdure and parched by drouth catches up particles of dust and sand and drives them violently into the air in clouds, or sweeps them along more quietly close to the surface where they are at first scarcely noticeable. The impact of a single one of these moving grains on any object

* Proc. Royal Geographical Society. Nov., 1889, p. 648.
† Travels in New England and New York. Vol. III., p. 101.

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Although first described as occurring in the valley of the Rhine, loess deposits have since been discovered occupying large areas elsewhere, extending from France eastward through the German and Austro-Hungarian Empires and far up into the Carpathian Mountains. Deposits of so-called loess are abundant in the United States, particularly in the Mississippi valley. Their æolian origin is here however a matter of grave doubt, their position and characteristics being more those of water deposits. If on further study the Richthofen theory should prove correct for these beds also we might readily conceive of their materials as derived from the arid regions of the west during the drouth which immediately followed the glacial period, as has been suggested by Professor Pumpelly.

The tendency of the wind is not in all cases toward forming

* Quaternary History of Lake Lahonton, Nevada.

† The sands covering the Egyptian Sphinx and pyramids are stated to have come mainly from the sea on the north, and not far from the desert, as is popularly supposed.

drifts and ridges, but at times rather to reduce the land to one general level. Thus J. Flinders Petrie* states that near the ancient cemetery of Tell Nebesheh, on the Isthmus of Suez, the surface of the country has been cut down at the rate of four inches a century until some eight feet have been removed from the dry areas and deposited in the intervening depressions, slowly converting the existing lakes into marshes, and the marshes into dry land. An even more rapid change of contours is that described by Dwight† as having taken place on Cape Cod, Massachusetts. The entire country here is composed of sand so susceptible to the drifting action of the wind that it has for years been the custom of the people to sow pines and coarse beach grass to hold it in place. In the instance described by Dwight, however, reckless pasturage had so far destroyed the grass as to lessen its protecting power and under the strong breezes from the open Atlantic it began to drift rapidly. Over an area of about a thousand acres the sand was blown away, to a depth in many places of ten feet.

But the agency of the wind does not end with the work of transporting the sand and dust. Particles of sand drifting along before the wind become themselves agents of abrasion, filing away on every hard object with which they come in contact. As a matter of course this phenomena is most strikingly active in the arid regions, though the results, when looked for, are by no means wanting in the humid east. It is thought by Professor Egleston that the inscriptions on many of the tombstones in the older churchyards of New York City have become illegible by the wearing action of the dust and sand blown against them from the street. There is to be seen in the National Museum, at Washington, a large sheet of plate-glass, once a window in a lighthouse on Cape Cod. During a severe storm of not above forty-eight hours' duration this became on its exposed surface so ground from the impact of grains of sand blown against it, as to be no longer transparent and to necessitate its removal.

Apply now this agency to a geological field in a dry region. The wind sweeping across a country bare of verdure and parched by drouth catches up particles of dust and sand and drives them violently into the air in clouds, or sweeps them along more quietly close to the surface where they are at first scarcely noticeable. The impact of a single one of these moving grains on any object

* Proc. Royal Geographical Society. Nov., 1889, p. 648.
† Travels in New England and New York. Vol. III., p. 101.

with which it may come in contact is infinitesimal, but the impact of millions acting through long periods of time produces striking results. Urged by the winds the grains go sweeping on, undermining cliffs, scouring down mountain passes, wearing away the loose boulders and smoothing out all inequalities. Naturally the abrading action on exposed blocks of stone is most rapid near the ground, as here the flying sand grains are thickest. First the sharp angles and corners are worn away, and the masses gradually become pear-shaped, standing on their smaller ends. Finally the base becomes too small for support, the stone topples over, and the process begins anew without a moment's intermission and continues until the entire mass disappears—becomes itself converted into loose sand drifted by the wind and an agent for destruction. W. P. Blake was the first, I believe, to call public attention to this phenomena, having observed it while in the Pass of San Bernardino, California, in 1853. G. K. Gilbert has also published interesting facts upon the subject as noted by himself while Geologist of the Wheeler Expedition west of the One Hundreth Meridian in 1871–72. In acting on the hard rocks the sand cuts so slowly as at times to produce only grooves or fantastically-carved surfaces, often with a very high polish. The geologists of the Fortieth Parallel Survey in 1867–73 described like interesting phenomena as observed on the western faces of conglomerate boulders exposed to the sand-blast of the desert regions of Nevada.

PERCHED BLOCK OF STONE ERODED AT BASE BY WINDBLOWN SAND, IN ARIZONA.

The finely-comminuted rock-dust blown from volcanic vents is drifted often for long distances by atmospheric currents, and deposited ultimately in beds of no insignificant proportions. Dense clouds of such dust were blown from Icelandic volcanoes to the

coast of Norway in 1875, and subsequent to the eruption of Krakatoa (in 1883) the ship *Beaconsfield* of Philadelphia, while at a distance of 831 miles from the source, sailed for three days through clouds of dust which fell upon her decks at the rate of an inch an hour. That such are not, or have not in the past been unusual occurrences is shown by results obtained by the *Challenger* Expedition, volcanic ashes and sand being dredged up repeatedly from almost abysmal depths at points in the central Pacific far remote from land areas. At various points in Colorado, Kansas, Nebraska, Montana and other of the western States are remnant beds of fine volcanic dust such as must originally have covered many square miles of territory, and the materials of which were derived from sources now wholly obscured. The illustration given on page 600 is from a photograph, taken by the writer, of one of these beds in the lower Gallatin valley, Montana. From the height of the man's shoulder to his feet the bed is of pure glassy dust, very light gray in color, and so fine and light that when thrown into the air it floats away at the slightest breath. The figures given show the appearance of this glass as seen under microscope.

So much for those comparatively recent changes in terrestrial contours which are traceable directly to the wind's action. Excepting that there is now doubtless a larger land area exposed than in the past, there is no reason for supposing the wind's power to have been less marked in ages more remote. Volcanic phenomena certainly have manifested themselves since very early times and the transported ejectamenta may have been even more abundant than in the instances described. The profound changes which such deposits have since undergone through the combined agencies of heat, pressure and percolating solutions render their identification in many instances matters of the greatest difficulty. The microscopic scrutiny to which rocks in the form of thin plates are now being subjected by students the world over, doubtless will be productive ere long, of many new and interesting results in this line.

AMERICAN MINING IN 1891.

By Albert Williams, Jr., E.M.

NINETY-ONE has been a great year in American gold and silver mining, on the whole more satisfactory than any previous one; not a period of excitement, of startling discoveries, of wild rushes and booms, but of tranquil prosperity. It has been characterized by a considerable extension of the known mineral areas, better distribution of profits, and a heavier production than ever before. This too, in the face of a depression in some other branches of industry, and with lower prices for some of the more important products, showing that precious-metal mining stands almost alone in being independent of the general course of "the times" in commerce, manufacturing and the other productive occupations. Without the evidence of trustworthy statistics such a state of things would hardly be expected to exist.

Only the briefest outline of the condition of the mining industry is here permissible. Even a complete statistical compendium would be impracticable, while an attempt in a single paper to enter into any detail as to the technical progress in mining and metallurgy would be out of the question. The present purpose, therefore, is to present a rough sketch of the existing status of mining as viewed from the business standpoint, and to indicate the general tendencies developed by the experience of the past year. Those who are interested in statistical detaiis will find a mass of information in the elaborate compilation of production-statistics published by the *Engineering and Mining Journal*, in a recent special number, from which the principal totals quoted in the following pages are taken. Popular attention is attracted to the mining of the precious metals rather than to that of the other more prosaic products. With the gold and silver a large proportion of the lead and copper is also produced, so that mining for these four metals is much intertwined. But in spite of common misconceptions about precious-metal mining, it is now just as "legitimate" a business as mining for iron ore or coal, it is hardly more speculative, and is conducted on much the same principles. It is this branch of mining which will be more particularly touched on in this review.

Changes in the general prosperity of the country affect mining in two distinct and opposite ways. The depression in so many branches of industry and commerce which marked the beginning of 1891 undoubtedly put a check upon the investment of new capital in mining, and the prevailing tendency to extreme caution caused managers to hesitate in projecting enterprises requiring large outlays before returns could be looked for. Consequently for a time fewer new mines were being opened, and while the total amount of work was very large, the active mines were operated conservatively. But a little later in the year the dull times, paradoxically, had a strong counter effect, which may be understood when it is considered that a large amount of capital had been suddenly thrown out of other productive employment and forced to seek a new channel. Notwithstanding the stringency in the money market rates of interest were comparatively low, and mining became the most attractive field for investment, for, barring those mining enterprises which require a long time for completion, mining usually returns quick profits if any, and its product, in the case of gold and silver mines at least, is always and immediately marketable with no dread of overproduction to restrict enterprise. It was probably considerations of this kind which, toward the close of the year, determined holders of idle capital to place it in mining, and in the last few months more large mine sales have been made than perhaps in any similar period before. This means, for the present year, a wide extension of development, better openings for labor, and a considerable gain in production.

The output of gold does not vary much from year to year. It would be considerably larger if the great hydraulic mines of California had not been hampered by adverse legislation designed to protect the navigable rivers and the farm-lands below them from damage by débris. There is a strong reaction against the repressive laws, which have indirectly hurt the farmers as well as the miners, and it will not be surprising if in time the resumption of hydraulic mining in that State, under somewhat modified conditions, should augment the annual gold yield. In 1891 the United States produced about 1,620,000 ounces from all sources—placers, gold quartz veins and mines yielding silver-lead-gold or copper-silver-gold ores, and the value was $33,250,000.

About 58,000,000 ounces of silver came from American mines in 1891, which would have a nominal value of $74,820,000 at the full coining rate, but which sold for much less as bullion. For 1890 the

output had been only 54,500,000 ounces, and the gain was thus a pronounced one. The silver production may be valued in several ways. The nominal coining value in this country is $1.2929 per troy ounce; the average of the quotations for the year is figured by the *Mining Industry* (Denver, Colorado), at $0.9855 per ounce, and the actual receipts of the producers varied considerably from that. Thus in comparing the records of a series of years, it becomes necessary to make allowance for fluctuations in the price of silver, if the product is stated at its commercial value. In 1891 the price fell off about 5½ cents per ounce from the average for 1890. It cannot be said that the market prices were affected by the increase in production; and on the other hand there are too many other factors besides the quotations involved in the mining problem to make it appear that they have any immediate or direct effect upon production. In the past year the yield increased and the price declined, but there was no necessary connection between the two changes, the price hinging mainly upon possible monetary legislation by the present Congress. Gold is always rated at its full coining value of $20.67 per ounce.

The Colorado statistics are particularly interesting as showing the advance made in the output of the foremost mining State. The statistics collected with commendable promptness by the *Mining Industry* show that in 1891 the yield of silver from Colorado ores was 23,102,355 ounces against 19,430,203 ounces in 1890, the commercial value being $22,767,370 in 1891 and $20,259,906 in 1890. Gold remained stationary—217,652 ounces as against 218,294 ounces in the preceding year, the value in 1891 being $4,498,866. Besides these, the lead and copper (63,198 tons of the former and 5,517,001 pounds of the latter) mined in Colorado in connection with the precious metals brought the total for the four metals up to $33,548,934, as compared with $29,881,334 in 1890. But the Colorado reduction works also treated ores from other States and Territories, and their total bullion output had a commercial value of $44,919,193 in 1891.

Without arousing much outside attention, some important exploratory operations have been pushed in several of the older silver districts, the underground prospecting amounting to the same thing as though entirely new fields were being developed. The deep shafts sunk at Leadville have disclosed an area of ore-bearing territory unexpectedly large, and at least much more extensive than at any former period, so that the future of that camp is as-

sured for a long time to come. At Aspen and in the San Juan country of Colorado long tunnel enterprises have been in progress, with the result of tapping the veins at much deeper points and thus opening out large blocks of ground for economical exploitation. On the Comstock an effort has been made to resume deep mining in the levels below the Sutro tunnel so long flooded. And in all the prominent districts a steady persistence in exploration has kept the development well ahead of the stopes—a point too often neglected in former days. Under the present system of mining it is not to be expected that any important district will suddenly drop out of sight on the exhaustion of its earlier ore bodies, for in the great camps there are many separate mines and usually more than one ore channel, and explorations are prosecuted over wide areas and at different depths, so that when some of the mines become exhausted or are temporarily in *borasca* others take their place. Leadville is an extreme illustration of how the average and total output can be maintained and increased, notwithstanding the extraordinary vicissitudes of individual mines and the uncertainties of underground prospecting under peculiar conditions. In districts where the ore occurs in well-defined veins easily followed and of ordinary regularity as to size and tenor, the output depends upon the amount of work done, and it is not difficult to forecast the outcome of a year. But most of the great silver camps have been characterized by pronounced irregularity, both as to the occurrence and the size of their ore bodies. Formerly many districts in Nevada, Utah and Idaho which were very productive for a short time were entirely abandoned after the first ore bodies, near the surface, were worked out; and it is very difficult indeed to resurrect an old district when it has once been given up. But now the tendency is to hold on wherever there is promise, and as underground explorations are more thorough the output is steadier and more uniform.

The practice constantly tends toward the handling of ore of lower grades. This does not indicate that the mines are poorer than in former times, but that cheaper transportation and reduction make ores available which were not so before; and thus while there is still plenty of rich ore coming out, the general average is brought down on the total tonnage by the large quantities of low-grade ore extracted, much of which has to be concentrated before further treatment. It is not possible to ascertain the total amount of ore mined with nearly so close an approximation as in the case of the bullion production, and estimates on average contents per

ton are therefore very unreliable. In Colorado the phenomenally high grade of the ore from a few shipping mines held up the average at between $50 and $60 per ton, with a probable slight gain on the average for the year 1890; but these figures are of course far higher than the run of the great bulk of the ore handled.

Among the new districts opened during the year several are fairly promising, and of these Crecde Camp and Cripple Creek in Colorado have attracted the most notice. In Montana the temporary suspension of a great copper mine sent many hundreds of unemployed miners into prospecting, and many discoveries were soon reported. Utah has had two new camps, one of which is probably a good one. The Seven Devils copper-silver district in Idaho has been further explored and will doubtless produce largely when better transportation facilities are provided. In New Mexico important developments were reported in the fall and early winter. While nothing like an old-time rush has occurred there have been several incipient ones, in which a few hundred to perhaps a thousand men have migrated to a new camp. Since little can be done in surface prospecting during the winter in most places on account of the snows, and there is little underground work in the newly-found districts, there will be many idle men waiting for spring to open, when renewed activity in prospecting will be the rule. The constant finding of ore in places which had been repeatedly traversed by prospectors before and had escaped discovery shows that the country had been (in the common phrase) only scratched over, and that the chances for striking paying deposits, other than placers, are as good now as ever, while the facilities for reaching and developing them are better.

Mining machinery is making small but steady advances, rather in the direction of economy than of efficiency. The compound engine is being used somewhat more frequently, as it ought to be, for heavy work such as driving Cornish pumps or mill-plant. The most noteworthy innovations in 1891 were the introduction of the electric drill and the electric pump. With these two additions it is possible to operate the entire plant of a mine by electric power—its hoisting, pumping, drilling, blasting, ventilating, milling, transporting, lighting and signalling appliances, and all from a single source. The electric plants installed in 1891 are very complete and satisfactory. The diamond core drill has also been modified to be run by electricity, and the core drill in all its forms has been in greater use, being placed upon many small prospects having no

other machinery. The quality of the equipment in the new plants is improving and cheaper prices place serviceable outfits within the means of mine-owners hitherto unprovided with them. Steel and iron "timbering" has not yet been adopted in the gold and silver mines, but with the exhaustion of the forests they may come into play. Coal has become a more common mine fuel, as freights are lower.

Metallurgic art advances with comparative slowness nowadays, but with positive certainty, so that each new step, however small, is pretty sure to be a direct gain. In some directions the margin for further improvement has already been cut down nearly to the vanishing point so far as regards high percentage in extraction of metal from the ore, as will be readily understood from the statement that in silver-lead smelting the ore is bought by the reduction works on a basis of 95 per cent. on the assay contents—which means that the smelters average somewhat higher. In the best practice in leaching and chloridation-amalgamation it is expected to save over 90 per cent. With such excellent technical results, progress naturally has taken the direction of improvement on the commercial side—that is, by centralization in a few great reduction plants, permitting closer economy in handling ore and products, by better transportation facilities bringing ore, flux and fuel together most cheaply, by the employment of large capital in buying ores at cash for the stock piles, and by the general saving in all details resulting from conducting any business on the great scale. The smelting companies have added very largely to their plant during the past year, and the additions made, now in progress or projected will increase the total capacity by about one-half, while some of the works have doubled their capacity. The Denver smelters, for example, which treated 390,000 tons of ore in 1891 and produced about $24,500,000 worth of bullion, will be able to produce nearly $35,000,000 in 1892 if fully employed, as there is every reason to believe that they will be. The technical advances in lead smelting latterly have been in methods designed to treat zinciferous and other refractory ores, closer saving and re-treatment of by-products, and in mechanical labor-saving devices.

Smelting has been steadily encroaching upon the field formerly occupied by the amalgamation process. Ten years ago half the silver ore was amalgamated; now the great bulk of it is smelted, and with far better results. Indeed silver milling will be almost extinct shortly unless some unexpected and wholly unlikely

revolution is brought about, as raw amalgamation is too wasteful and chloridizing-roasting in connection with amalgamation too expensive. Formerly silver mills were the main reliance in outlying districts far from smelters, but now most camps of importance are reached by railroads and can ship their ores long distances to smelting works. Lixiviation holds its own. The approved methods in vogue for many years for treating both gold and silver refractory ores by leaching are still in use, while during 1891 two or three new processes were tried on the working scale. Attempts have also been made to utilize low grade ores by leaching, which is a new departure, since hitherto the method had been thought applicable only to rather high grade ores.

Many concentration plants were put up in 1891. Some are operated in connection with the free gold mills and are designed to recover the sulphurets which escape amalgamation, but the more important field at present for concentration is in making marketable the low-grade silver ores, of which great quantities opened out in former years have lain idle awaiting cheap concentration means. Reducing the bulk of ore to be transported from five or six tons to one ton makes all the difference with many mines.

Placer-mining yearly grows relatively less important, though several quite large enterprises of this class began production last year. The deep ancient placers will be worked for decades or centuries to come, wherever there is no conflict with the farming interests, but most of the shallow river placers have long since been discovered and worked out. In 1891 no important finds in this class of deposits were reported. There remain in the Southwest certain dry placers, now unproductive, to which water will be brought in course of time.

The railroads have closely followed up the mining discoveries of the year where the outlook was encouraging and the connections not too remote. Nearly every district of any long standing has its railroad outlet, and in the case of one new camp—Crecde—the railroad branch was pushed out toward it before the outside public realized that there was anything there. In the Far West the principal revenue to the railroads is from the mining custom—freight on ores out and supplies in, with a light passenger and general freight traffic. Railroad managers therefore make it a point to keep themselves well posted as to the possibilities of newly-discovered districts, and endeavor to take advantage of them as early as possible. They also generally fix the rates as high as the traffic

will stand, and thus cause much complaint. However, the network of steel rails spread over the almost insuperable mountainous regions where the mines mainly are, is not only a monument to the enterprise and business sagacity of the railroad men, but of vital importance to the miners, for without the roads fully half the mines would be unworkable. Even as it is, the freight question very often is the decisive point as to profit or none.

There was very little speculation in mining stocks in 1891. The public for some years has been shy of them, as vehicles for gambling, while quite ready for permanent investment. There was a spasmodic, short-lived spurt in Comstock shares in the spring. Otherwise the share market was unusually quiet. Stock speculation has, it must be admitted, benefited mining to a certain extent by enabling large enterprises to be floated and bringing in capital in small amounts; but on the whole the evil effects have far outweighed the good. It is no longer necessary to make stock "deals" to interest capital, which now goes into mining as a regular business just as in other productive industries, looking to the mines, not the exchanges, for returns. Many of the most profitable mines are held by close corporations which prefer not to list their shares.

Speculation in mining properties, however, has not abated. Without it, and without the intervention of the inevitable middleman, it would be difficult to bring mine-locator and capitalist together. But of the many heavy transfers effected during the last few months, involving of course intermediate "deals" of which the public hears nothing, none have created scandals such as disgraced the mining history of former years. When the buyers purchase with the intention of really mining they are likely to look rather closely into the nature of the investment, and however liberal they may be they are better educated now.

English corporations owning gold and silver mines in the United States have been more fortunate in their investments of late, because of greater caution in selecting properties and by doing better mining. The favorable reports and the profits from their active mines have induced other English capital to take up American mines. A number of undoubtedly good properties, including a few very big ones, have thus recently passed into foreign ownership, at prices fully as high as warranted by the showing of the mines.

The immediate prospect for gold and silver mining and for the metals mined in connection with them is extremely bright. The industry has settled down to a business-like basis and is conducted

with greater technical skill and certainty than ever before. The output this year probably will be larger even than that of 1891, not so much because of any extraordinary finds as because of the greater number of working mines and the opportunity which enlarged concentrator and smelter capacity and railroad extension will offer for the treatment of known reserves of medium ores and concentrates from low-grade ores. Precious-metal mining will employ more men in 1892 than in 1891, and, by adding largely to the wealth of the country react favorably upon other industries.

Iron-mining was one of the few branches which showed a decline from the previous year. There were only 8,976,000 tons of pig iron made, against 10,307,028 tons in 1890, these figures standing for about a double tonnage of iron ore mined. The falling off indicates no lessening in the productive capacity of the mines, being due to a slackened demand for steel rails and general iron and steel manufactures. There was a considerable increase in the copper output, the total for 1891 being 146,310 tons, or 13,850 tons more than in 1890. Lead also gained; 205,488 tons last year, against 181,494 tons in 1890, with prices slightly lower. Zinc made another advance in production, reaching 76,500 tons. Nickel fell off about a quarter, only 144,841 pounds being made in 1891. The output of quicksilver remains steady, last year's production being 21,022 flasks. Nearly twice as much aluminum was made in 1891 as in 1890, the product being 163,820 pounds. Practically the first American tin was made in 1891, the output being 61 tons, mostly from the California mines. The amount of coal mined was greater than in 1890, being 42,839,799 tons of anthracite and about 98,000,000 tons of bituminous coal and lignite, though prices were lower.

Besides those mentioned there are many minor mineral products —antimony, phosphate, rock, marl, salt, bromine, sulphur, pyrites, gem stones, mineral paints, etc.—to say nothing of the great quarry products of building and ornamental stone, roofing, slate, fire and brick clays, cements, and so on. Petroleum and natural gas are also to be included. It is impossible to say exactly what the total value of the whole annual mineral yield is, since some of the products have little value in the crude state, while no definite values can be set on most of the ores. But adding the value of the coal and petroleum to the metallic and other mineral products, the product of our mines for several years has exceeded half a billion dollars annually, and for 1891 the editor of the *Engineering and Mining Journal* estimates it at $650,000,000.

AMERICAN SUPREMACY IN APPLIED MECHANICS—III.

By Coleman Sellers, E. D.

BEARING a close analogy to machine-tools, with the steel cutting points dispensed with and their place taken by abrading material, we find a line of inventions that enable both soft and hard metals to be worked by means of revolving grinding-wheels coming under the trade name of solid emery-wheels. These are artificially-made grindstones capable of bearing a high speed of rotation and removing metal with surprising rapidity. The solid emery-wheel originated in Great Britain, but has been perfected in the United States, where the many machines to apply it to various uses have been designed and built and where many manufacturing establishments are devoted to this industry either wholly or in part, and compositions when not protected by secrecy are covered by a long line of patents.

In 1878 Mr. Arthur Bateman, F. C. S., a well-known maker of solid emery-wheels in Great Britain, read a paper before the Society of Arts in London giving the history of the industry, and dating its origin with a Mr. Henry Bateman, who, in 1842, patented a composition for uniting emery to form a solid wheel. Claiming the invention as British he says: "The development of the idea has certainly taken place on the other side of the Atlantic, and we are now appearing to be copying our American cousins in our tardy appreciation of a *bona fide* English invention."

Mr. T. Dunkin Paret, in his lecture on emery-wheels before the Franklin Institute in Philadelphia recently, he having been in the business of making such wheels since 1867, showed how the comparatively new tool can be made to take a leading place among machine-tools with a judicious development of the machinery that is designed to make use of the rotating emery-wheel as a cutting-tool. The question of the utility depends upon the scientific study of the action of abrading material at various velocities, on the composition that will bind the cutting particles together with a sufficient firmness and durability, on the qualities that will allow free cutting and the exhaustive study of the many mineral substances that pos-

sess qualities fitting them for this use, but lastly in the development of machinery that will render this new cutting process controllable as to direction and safety.

In the year 1831 or 1832, Mr. Jacob Perkins exhibited in London a revolving disk of metal to which he had imparted sufficient speed to make it a means of cutting hard steel. From this first exhibition has sprung the many machines that are now classed under cold-sawing methods, in which the cutting is effected by a disk of metal revolving so rapidly as to engender a heat due to friction sufficiently high to cause the revolving disk to burn its way through the metal by a local disturbing action so rapid and violent as to confine the heat to the points in contact and to permit the cutting of cold steel or iron almost as readily as wood can be parted with a circular saw ; the cutting-tool, a toothless disk of metal through the agency of which power is converted into light and heat, yielding the mechanical equivalent of heat generated in proportion to the force expended.

The development of cold-sawing machines in the United States was hastened by the perfection of high-speed steam-engines. Each great advance in applied mechanics in the United States will be found to depend upon and be associated with some facilitating impulse depending upon the state of the art in the country that favors this advance.

In England Sir William G. Armstrong, since raised to the peerage, in his early engineering life developed and applied the principle of the hydraulic press to hoisting purposes. In the United States the passenger lifts, or elevators, as they are now styled here, worked out on independent lines of thought, have earned for their inventors and manufacturers world-wide reputation for safety, rapidity of motion and perfection of mechanism.

The modern elevator has during two decades quite changed the profile of many great cities. From Jersey City, New York twenty years ago presented to the eye a line of low, level buildings, showing no striking architectural outlines. This was first broken by the granite piles on Broadway, then along other streets rose building after building, until the whole outline of the city against the sky was changed, and this remarkable change was brought about wholly by the possibilities of vertical railroads rendering the upper rooms of high buildings more desirable for office purposes and residences than even those nearer the ground. Such cities as New York, with their elevated roads giving rapid transit horizontally, have through

their hoisting systems obtained vertical railroads and rapidly-moving cars that have thrown the staircases in the same buildings into disuse.

The progress of the work on the great bridge recently completed at Queen's Ferry, near Edinburgh, Scotland, was watched with interest by American engineers, who visited it from time to time and saw it grow in the acres of shops that were erected at the place to construct this enormous work from the plate-iron and bar-iron as it came from the rolling-mill in shops and with machinery that would become useless and must be removed upon the completion of the structure. This mode of construction and erection was in strong contrast with the bridge-building methods of America. Iron and steel bridges of good design and of undoubted strength are being erected here that are made in large manufacturing establishments far removed from the site of erection and are arranged so as to require no work in assembling the parts and putting up the structure.

The large iron bridge over the Susquehanna near Harrisburg, Pa., was erected in six months from the date of order without any hand work, such as chipping or altering, and the progress of the erection did not interfere with the travel over the road. The problem in this case was very much like that of the erection of a county jail decided on at a meeting of the county magnates who resolved unanimously that a new jail be built; resolved also unanimously that the new jail be built on the site of the old jail, and further resolved unanimously, that the old jail shall not be removed until the new jail is ready for occupancy. The wooden bridge, over a mile in length, across the river where the iron one was to stand, served during the construction for the roadway and for the false works used in the erection of the new one. To those who crossed the bridge during the period of erection it was simply a gradual transition from wood to iron that met the eyes.

The shops required to do this kind of work are equipped with hydraulic machinery for making the links, with special boring-machinery for boring them with accuracy, with shearing and punching machines for plate work and hydraulic or other power riveting devices for uniting the metals. Multiple punching-machines have been perfected to space the required holes in such work with the utmost accuracy, the spacing being regulated by a process analogous to that used in weaving figured cloth by the Jacquard system.

It has been rendered possible by means of such manufacturing establishments to do the work more rapidly and more thoroughly than is possible in shops built for the occasion and to which in out-of-the-way places skilled workmen must be carried and domiciled during the term of erection. With very large manufacturing establishments of this kind there must be the homes for the workmen. The comfort and health of the workmen has much to do with the quality of the work they turn out and its cheapness; hence the advantage of locating such establishments near cities or towns that afford good living accommodations for the working class.

In the treatment of this subject and the consideration of American progress, it is eminently fitting that comparison should be made between methods in other places and customs at home. A recent visit paid to many workshops in England and on the continent of Europe, especially in Switzerland, revealed the fact that American improvements have found their way to Europe and been adopted there. The contrast between establishments where turbine wheels are made in America and where they are made abroad is manifest in one important particular. In America, with designers of special kinds of wheels working for a certain end and laboring experimentally to bring about the best results, the result is many manufacturing establishments each making some particular kind of wheel and usually protected by patents. The production of these wheels in America is reduced to a system. They are manufactured into quantities of progressive sizes and are well fitted to fill the ordinary requirements.

In Switzerland a different system is followed in their extensive establishments. A very high order of talent is employed, aiming at the best scientific results, regardless of any special patented feature. Some of these houses have introduced improvements that they secure to themselves, as, for instance, in their very excellent method of governing speed and also in some of the details applicable to their work, but while they may manufacture a certain line of wheels suited to ordinary cases they are all prepared to furnish wheels adapted to the location and showing a greater scientific knowledge of the whole subject of wheel-making than obtains with some of the makers in America. It would be invidious to mention any of these establishments by name, much as I am inclined to do so, but no mechanic can spend any time in the inspection of the work done there without bringing away with him much that is worth copying. He will feel sure that while America is advancing

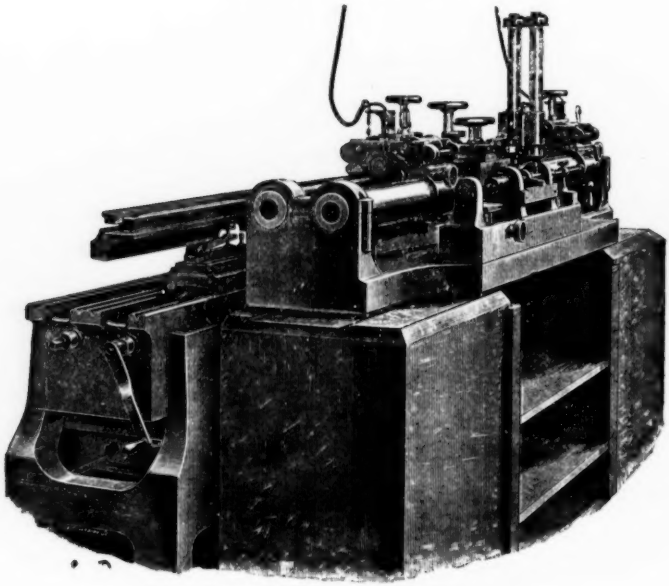
rapidly in applied mechanics, yet the rest of the world is not standing still, and it behooves the American engineers to increase their power for usefulness by availing themselves of the highest scientific methods.

The apparent strength and seeming solidity of engineering construction in the older countries, so impressive to observers from America and so unlike American methods, is not confined to the greater engineering works, but is strikingly illustrated even in the hardware for building purposes. In both countries, however, on the same shelves, can be found for sale the flimsiest as well as the best examples of what may be required. Artistic house hardware, as more recently produced in America, is superior to any made elsewhere. The workshops at Stamford, Connecticut, and in many other parts of New England, some of them dating back through many years of active improvement, challenge the world in such work as they produce, in the perfection and convenience of the many specialties to which they have directed their inventive faculties, while many of these workshops are characterized by remarkable administrative ability that has been able to introduce such novel methods.

SAMUEL COLT.*

It is from the American machine-shops that the machinery for the manufacture of small arms goes to equip the foreign arsenals, while the instruments of precision from Providence, Hartford, and elsewhere are to be seen in the hands of workmen of all countries. The measuring devices perfected by the late Sir Joseph Whitworth have been surpassed in accuracy and capability by men in America who have turned their attention in this direction, while the Comparator of Professor Rogers and Mr. Pond as built and operated by the Pratt & Whitney Company has carried the accuracy of possible measurement beyond any previous effort. The great testing machine at the Watertown Arsenal, Mass., built on the plan proposed by Mr. A. H. Emery, has in the

* Samuel Colt, born Hartford, Conn, 1814; died there, 1862. Entered his father's factory at the age of ten, left to go to sea, returned and took lessons in chemistry. The first model of his pistol was made in wood in 1829, on board a ship. In 1835 he took out his first patent for revolving fire-arms, the forerunner of the great invention connected with his name. His factories at Hartford supplied a large portion of the machinery for the armory of the British Government at Enfield, England, and the whole of that for the Russian Government armory at Tula.



PROFESSOR ROGERS'S COMPARATOR.

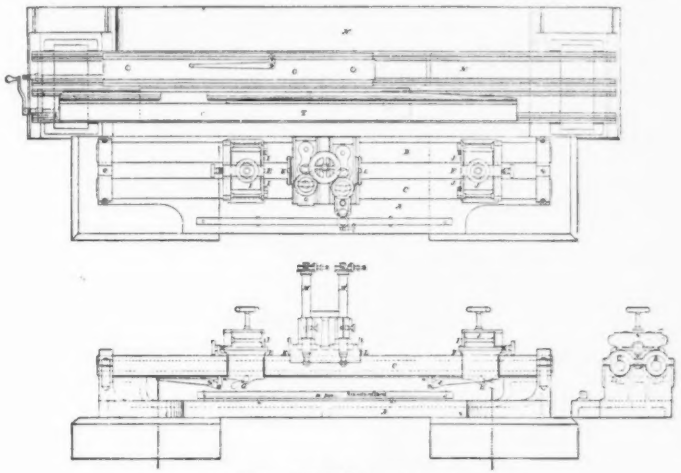
hands of the Government officers since 1879 given to the world a vast amount of valuable information as to strength of materials, while for delicacy and precision this method of testing the strength of material stands alone in its possibilities. To the non-technical reader it may be interesting to know that this machine, which is capable of testing the tensile strength of a human hair, was by contract designed to submit a compressing strain of one million pounds, and to rupture a wrought iron bar five inches in diameter by tension.

The much traduced metrology of England and America lends itself most happily to standard sizes that can be readily memorized and readily used. This does not come from any particular merit in the English inch but in the non-use of a purely decimal division of a unit. The inch divided into fourths, eighths, sixteenths, thirty-seconds and sixty-fourths by successive halvings, permits a graduation of sizes that can be memorized, making shop sizes to vary by a sixteenth of an inch up to one inch or two or three or a quarter inch above that size, presenting a memorizable series of sizes that is as natural as the divisions of music.

In countries using the metric system the millimeter is the unit of the machine shop and an iron rod one inch in diameter called 25 millimeters even when it measures 25 4-10 exact, and drills used in the shop for advancing in size by a millimeter, from 4 millimeters to 25 will give more separate dimensions than are really needed. Economy in shop equipment is found in the use of only a limited number of progressive sizes, as each standard dimension requires many separate pieces in all the tools made to that size; even in a modern tool room, counting all the taps, drills, reamers, gages, boring tools, turning and planing tools for any one given size, there will be found from 70 to 140 separate and distinct tools to each size. The multiplication of sizes is attended with great cost in stock and no compensating gain.

In practice, the metric nations use the empirical graduations of shop sizes, advancing by two or three millimeters in a series that is not uniform but nearly approximates to the separate gradations in use in rolling the iron turned out by the English rolling-mills, which are scaled to the usual division of an inch, five-eighths, three-fourths, and so on.

The French centimeter may be divided as we divide the inch, but with the new divisions of the centimeter in halves, quarters, eighths and sixteenths, comes the destruction of the decimal system, which in truth is of less value when applied to measures and



PROFESSOR ROGERS'S COMPARATOR.

weight than it is in currency, and the intensity with which the British nation holds to its duodecimal system of money and the rapidity with which even the most ignorant use this seemingly complicated currency shows that there is not so much merit even in the decimal system of money to introduce it when a nation must be taught new habits of thought.

Long before the metric system was legalized in America, the present writer readily agreed to its adoption in a large department of the workshops he was then interested in, in order that in doing one particular kind of work which lent itself readily to the metric metrology, the experiment could be tried as to its superiority over that in common use, but with the result of satisfying himself that it was very far from meeting the exaggerated claims made for it by its advocates.

The metric system is now legalized in America, and with this legalization legislative action should end. Let those new branches of trade that are springing up, the new developments of art and science that can use the metric system to advantage, do so. The present condition of metrology with the English-speaking nations adhering to a non-decimal division of the inch with all Russia to back them in it, the time is not come, if it ever will, that this great population should be compelled by legal action to depart from standards and methods that have been accompanied by such surprising advance as has been shown in the nineteenth century. This is the more true when men willing to test the new metric system find it, after more than a quarter of a century's use, less advantageous than has been represented in some branches of applied mechanics. Those only are capable of judging of this matter who have become familiar with both systems to the extent of being able to think in either system of metrology as readily as some men can speak and write several languages.

There are cases in which the metric system can be used universally ; in such cases let it be used ; let it be taught in the schools, then through the survival of the fittest the truth will be reached. Chemists and electrical engineers should be free to use what is best, while those who are familiar with pounds and ounces should be free to buy and sell with the weights and measures most familiar to each.

Between the years of 1819 and 1871 the name of Henry Burden was conspicuously before the engineering world as a man who contributed largely to the advance of applied mechanics in the United

States.* Born at Dunblane, Scotland, in 1791, he came to America at twenty-eight years of age, and in 1833 was building steamboats on the Hudson River with his own means. He was perhaps the originator of the plan of building berths upon the decks of boats, and he certainly contributed largely towards the early introduction of quick sailing boats upon the Hudson. Years went by, and as one subject after another engaged his active mind, it is difficult in the absence of a properly written biography to determine in what direction he accomplished the most. When consulting with Brunel in London about the *Great Eastern*, he declined to have his name connected with that vessel, believing that it would put ship-building back fifty years on account of the vessel not having power enough and for other reasons. Glasgow engineers were then only too willing to claim him as a countryman, but he always strenuously insisted that "all that there was in him came from American institutions, from American air." We seek such names as Henry Burden to illustrate the theory that it is opportunity and the propinquity to the localities where the conditions favor mechanical progress that this advance is so very marked.

The great water wheel at Troy, which for many years stood as the example of the largest overshot water wheel in the world, drove part of the Burden works that for so many years have been celebrated in the iron and steel producing industry of America, and Henry Burden's method of treating puddled iron by the rotary squeezing process was adopted in most of the American rolling mills immediately after his conception of that idea.

In this treatment of the subject, however, what should especially claim our attention is his invention of machinery for making horse and mule shoes. In 1835 Henry Burden took out his first patent, and from that time down to the present day continued improvements have been added to his primary invention. For many years the works at Troy monopolized this industry in the face of many other inventors attempting to introduce competition, but the real opportunity for active competition did not occur until 1861 or 1862, when the war of the rebellion created such a demand for the product of these works as to cause the Government to threaten to take possession of the works for its own use unless the shoes required for the cavalry and artillery horses were forthcoming. Then other establishments came into existence, notably at Providence, Rhode Island, and since then and after the expiration of some of

* A portrait of Henry Burden occurs on page 443 of the January number of this magazine.

the earlier patents, horse-shoe machinery has become an almost necessary adjunct to the rolling-mills of all parts of the country, just as nail-cutting machines are used to turn part of the product of the mill into a merchantable article other than bar-iron.

Fifty-six years—more than half a century—have gone by since horse-shoes were first made by machinery in the United States. During this half century few similar industries have been attempted in other countries and America, after this long period, stands almost alone as a producer of what is here considered an important industry, while owing to the habits and customs and prejudices of other countries, there is little or no demand for this product, or at least not sufficient to warrant the introduction of machinery to compete with the American rolling-mills. No more striking example can be found to support the theory that American supremacy where it exists in applied mechanics is due largely to the opportunities afforded from the beginning in this country.

CHARLES GOODYEAR.*

In the improvements in shafting and mill gearing in all that pertains to the transmission of motion by line shafting, by belts and by gearing, the work of American engineers stands out in bold relief, and American methods are accepted as correct in all countries. Professor Willis in his "Principles of Mechanism" many years ago called attention to what had been accomplished in the United States in the use of belts in place of gearing. Line-shafting requires some device for uniting the separate lengths called couplings; some means for supporting the shafts and permitting free rotation with little friction, such as hangers and pillow blocks. For belt transmission, pulleys carefully balanced to run true, with many other convenient devices, are required. Heavy shafting suspended from the beams overhead in factories are likely to be thrown out of line from sagging of the floor due to heavy loads and by the sinking of the foundation. To meet this difficulty, the self-adjusting, swiveled hanger bearing, permitting ready adjustment, came into

* Charles Goodyear, born New Haven, 1800, died New York, 1860. He entered his father's steel hay-fork factory, and upon its failure was attracted by the unsatisfactory character of India-rubber manufactures. His experiments, pursued for many years under discouraging circumstances, resulted in his obtaining in 1844 his first patent for the vulcanized rubber, which was followed by several others.

common use in the United States long before they were recognized elsewhere, and one by one inventions were added to the list of devices required to fill all the wants in line shafting, each having some merit, either in security or durability, in case of erection or in efficiency of transmission.

Taken together, the manufacture of shafting and mill gearing at an early date came to be reduced to a system, and many factories have sprung up having in view this one requirement of modern mechanical processes. Shafting (a name applied to all that pertains to its use) is now made in interchangeable parts, requiring little purely manual skill in construction or erection, and the catalogues and price-lists of the shafting makers show how perfectly this business has been systematized and reduced to a condition of regular manufacturing processes like weaving cloth. Miles of shafting, and all that is required for it, are now carried in stock, ready for immediate erection.

SAMUEL SLATER.*

Celluloid, an intimate mechanical mixture of gun cotton or collodion cotton with camphor, was first made by Hyatt, of Newark, in the United States, who discovered that by adding pyroxolin to melted camphor and strongly compressing the two substances together or by dissolving the constituents in the solvent alcohol and evaporating to dryness, what is now called celluloid would be produced. This is one of the many American discoveries that have played no inconspicuous part in the advance of the mechanical arts, and have stimulated invention not only in the production of other allied material, but in applying the new materials to new uses as well, thus greatly advancing the arts to which these new substances are particularly adapted.

The opening of the oil-wells in Pennsylvania and the extraction of oil from cotton-seed in the South met the diminished yield of the whale-fishers, partly supplied by the enormous production of lard oil in the West and the great discoveries of the products obtainable from the several oils. The tallow-dip has been replaced by

* Samuel Slater, born in England, 1768, died in Massachusetts, 1835. He was an apprentice in cotton-spinning under a partner of Arkwright, and came to America to introduce the latter's invention. At Pawtucket, R. I., in 1790, the first cotton-spinning machinery was set in operation, having been made by Mr. Slater's own hands or under his instruction, and the result was equal to the British products. From this dated the great cotton-manufacturing industry in America.

the kerosene lamp and the many new hard candles, in all of which developments American ingenuity has been stimulated through proximity to the source of these new organic or mineral products.

As bearing on the recognition of American ingenuity in other countries, American engineers visiting foreign workshops meet with a hearty welcome, and those well known at home are consulted as acknowledged authorities. In some cases they have been given access to works closed to most visitors. To one such visitor it was acknowledged that his type of machinery was being copied as of superior excellence and many questions were asked as to the methods obtaining in American workshops.

Progress in applied mechanics has gone on everywhere against many opposing forces. Opposition in some instances has been less violent in this country, and if so, the diminished friction between the inventor and public in America may have helped to accelerate our advance. The history of the screw propeller is an example of this difference. It is filled with the names of inventors both in Europe and the United States back into the last century, but to John Ericsson, a Swede, has been awarded the honor of its successful introduction into practice. It was in England that Ericsson achieved this success, but Sir William Symonds, who was the Surveyor of the Navy of Great Britain, expressed his opinion that "even if the propeller had the power of propelling a vessel, it would be found altogether useless in practice because the power being applied at the stern, it would be absolutely impossible to make the vessel steer"! *

In the face of this, Francis Pettit Smith's screw vessel went to sea in the course of the same year, and it was an American naval officer, Captain R. F. Stockton, who at the same time recognizing the advantages of the system, ordered two iron boats to be built with screw propulsion, and was so enthusiastic in his endorsement of the principle that it led to Captain Ericsson leaving England and taking up his residence in New York, where he contributed many valuable inventions to the progress of applied mechanics and where he died, filled with honor. This is a striking example of the inducements offered by the greater field and greater freedom of thought in America, operating in this case to draw Ericsson westward as it has done with so many able workmen.

That local customs influence trade and methods can be shown in that American dentists, aided by the inventive faculty of the manu-

* "Men of Invention and Industry," by Samuel Smiles, LL.D., London, 1884.

facture of dental appliances, are appreciated for reasons that hold in other cases, and made possible through the customs of the country in one case and retarded by older customs in older countries. Dentistry is divided into two general classes, one somewhat allied to surgery and dependent upon medical training, coupled with very considerable manual skill, while the other is mechanical dentistry The reputation that has been achieved by Americans in this branch of surgery and also in the mechanical part of the profession, has been a striking instance of the development of the inventive faculty on the part of those who have practised it and also advanced by the great amount of talent and business ability that has been displayed in the manufacture and preparation of the instruments and conveniences that are required by the practitioner.

A close examination into this subject, particularly as it bears upon some of the more recently adopted systems, will incline the student to the belief that customs of country have much to do with this progress. The professional dentist in adopting the code of ethics of the medical profession is aided or hindered, as the case may be, by the business methods of the country in which his lot is cast. So long as a professional man, in opposition to all well-known business methods, endeavors to adhere to the old traditions such as the receipt of fees without an itemized bill for service rendered, attempting to keep up the fiction of working for humanity and not for money, he is apt to find the most profit in doing the least work and adopting the cheapest methods when the fee for attention or service is uniform, regardless of the work done.

In America, from the beginning of the discoveries that led to the present perfection of dentistry, the custom has been for the operator to charge for his time, more or less, according to his skill or reputation, and to charge for the material used in some proportion to its value. If teeth are to be stopped, as they call it in England, or filled or plugged as we style it in America, at a uniform rate of a guinea for each sitting, it certainly is to the advantage of the practitioner to do the work in the easiest manner and with the cheapest material.

In the manufacturing branch of trade that supplies the dentist with his material, a great industry has sprung up that has incited to exertion some of the best talent of the country. Instruments have been brought to a high state of perfection; the manufacture of artificial teeth has reached the stage of artistic excellence, and the improvements made in the introduction of all the labor-saving

devices and the application of electricity to the motive power of these different machines, have kept busy a long line of inventors and made colleges of dentistry not only possible but an absolute necessity in this country, to which students from all countries come for instruction. An English dentist, coming to the United States to study after having practised for some years in England, acknowledged in 1890 that he had never seen gold used in filling a tooth. Reference to these customs and habits in connection with dentistry is warranted in any study of mechanical processes because it illustrates the influence of custom upon the progress of an art.

Its parallel is found in the case of a machinist who had his shop convenient to one of the Northern lakes and had much to do with the repair of the machinery of the steam boats. This worthy man objected to superior lathes and planing machines that were said to be able to do more work in a given time on the plea that it was time he was working for, not quantity of work. He asserted that it was not good policy to use drilling machines driven by power because a hole drilled by hand would take longer and yield a better return, as the class of people who ordered this work would be dissatisfied with his charges, yet they would pay willingly having witnessed the labor actually exerted by a man with a ratchet drill, but any rate of charge would be considered extravagant for the rapid work of lathes and planers, and that they would see done by power while inspecting the progress of their work.

The great extent of country in the United States under one government does not of necessity involve absolute uniformity in the habits and customs of the people. Before the introduction of railroads local customs and local differences between the various communities were more strongly accented than now, but the condition of local peculiarities that holds in all countries is perhaps less marked in America than in Europe. In England differences of speech and peculiarities of the several parts of the country have been maintained, at least among the lower classes, to a greater extent than here. In studying the state of the arts in a country, the habits and customs of its people must be taken into consideration to form any correct judgment of what has been done. Thus communities in the United States differ in their methods of conducting business, and afford opportunity to study effect of methods. A community wholly dependent upon manufacturing enterprise, such as many of the large manufacturing towns of New England, will have the manufacturing instincts of its people quickened and

developed. Large cities like New York and Philadelphia will develop mercantile interests, and the banks will in the beginning know the merchant better than the manufacturers. In one of the last named cities, before the war, a tradesman of doubtful reputation could obtain bank accommodations that would be refused to a manufacturer through the ignorance of the men who sat as directors in the several banks, and who, being tradesmen themselves, were committed in favor of those best known to them personally.

It so happened that when war came and the very foundation of credit of the banks was shaken, that the manufacturers, so little known in these cities until that time, came forward and helped in matters of finance, and when the vast needs of the Northern armies gave such impetus to manufactories on one side, while the same war was limiting commerce on the other, the country came to regard the importance of what was bringing wealth to the cities by actual creation and not through barter and exchange. Then came to be established the mechanics and traders' banks, and inventors and mechanics became presidents and bank directors. Then began to grow those great manufacturing establishments with large clerical forces that are developing in the line of the sound mercantile method of using the highest technical talent under economical control.

A machinist of Philadelphia who had made for himself a competency and had settled down to enjoy the fruits of his industry was made director in an old and long-established banking institution. He found to his surprise that neither farmers nor mechanics were recognized, but the tradesmen and merchants were the chief customers of the institution. In an effort to bring together the heads of the mercantile and manufacturing community, he invited some bank officers to visit the large workshops where locomotives and machinery were made ; then, later, ostensibly to hear Dr. Kane deliver a lecture on "The Open Polar Sea," gave a dinner to which he invited and seated at the table alternately, bankers, mechanics and merchants ; this with the sole intention of correcting a fault which as he thought existed in the community, and to advance the mechanic arts. It was soon after this dinner that the Civil War came and slavery was abolished, and now after nearly three decades the rich mineral wealth of the South is being developed and added to that of the North. The manufacturing instinct is springing up in the South with the promise of results far greater than were dreamed of during the time of the existence of slavery.

The homes of working operatives have much to do with their interest in their work. A country where every man can hope to become the owner of ground on which his house rests and of the garden that joins it, can develop a class of workmen who have more interest in life than the mere earning of wage sufficient to meet the rent exacted by their landlords and to pay the taxes that weigh upon them and to get them the beer that to them is a necessity.

The home habits of the people in different parts of the United States differ so much in different localities, and in each the effect of location and surroundings should be studied separately. In some quite large cities, as for instance Philadelphia, the workmen have developed good business methods in the conducting of building associations, through the agency of which the subscribers have been enabled to erect for themselves not only comfortable homes to live in, but to erect other houses that become a source of income to them. It is no uncommon thing to find a mechanic in America first building his own house and then adding from his savings other houses to his little collection of real estate, perhaps after a time becoming himself a manufacturer and employer of other workmen. In other manufacturing towns, the working people have a fancy to invest in the companies for whom they work, owning shares of stock in the manufacturing companies carrying on the business and paying less attention to the possibility of becoming landholders.

[*TO BE CONTINUED.*]

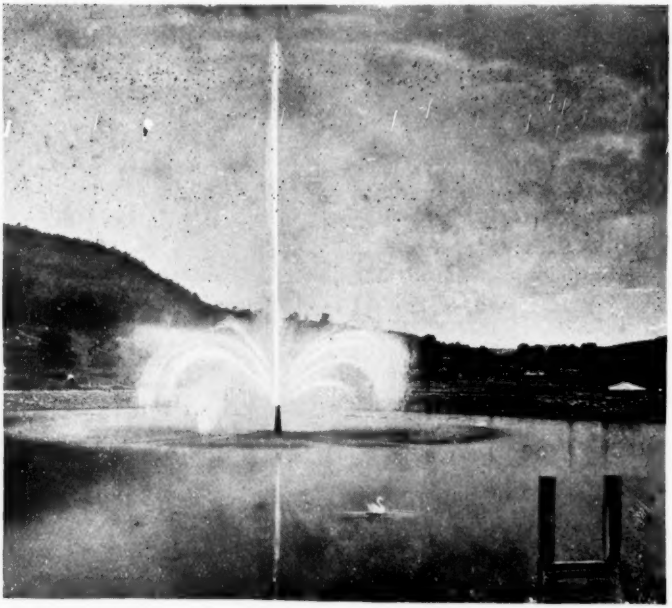
GRAVITY SYSTEMS OF WATER-SUPPLY.

By George W. Rafter.

IN classifying water-supplies with reference to safety and certainty under any and all conditions one may easily place gravity supplies first. When such a supply is derived from a deep mountain lake, of sufficient elevation to permit of delivery from one hundred to two hundred feet above the municipality, ideal conditions are attained, and nature may be said to have exhausted her resources in this direction in providing for the comfort and convenience of civilized man. Gravity water-supplies in all ages have demanded the highest skill of the engineer, whether in the design and construction of great masonry aqueducts or in devising methods of distributing water to the different parts of cities. The present paper however is not specially concerned with masonry constructions; its object is rather to call attention to a few of the underlying principles of iron-conduit gravity supplies as exemplified by recent practice in two or three American towns.

First and foremost a gravity supply is operated not only without machinery but without any expenditure for power. The universal force of gravitation carries the water to the fortunate municipality and when there and confined in pipes its stored energy may be utilized directly for fire-streams, the driving of motors and elevators, the flushing of sewers and for the many other uses of a public water-supply. In the United States and Canada there are nearly seven hundred towns with gravity supplies. There are no statistics for proving the proposition with exactness, but it may be stated in a general way, assuming that the works have been rationally designed, that in these seven hundred towns the certainty of operation of the water-supply, under all circumstances, is somewhat better guaranteed than in the fourteen hundred towns in which pumping is by reason of the conditions an integral part of the water-systems.

In a paper on "The Equipment of Pumping-Stations," in the November (1891) number of THE ENGINEERING MAGAZINE, I pointed out some of the more salient reasons why the uninterrupted operation of a public water-supply is imperatively necessary. A duplication of the main-conduit lines of a gravity supply can be con-

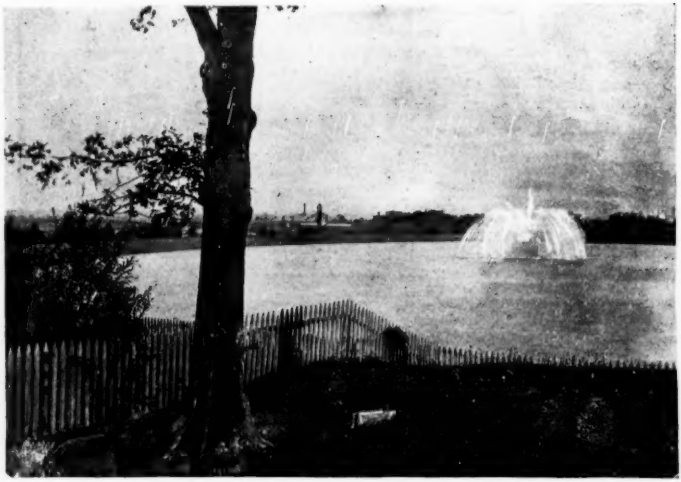


FOUNTAIN AT WATER-WORKS RESERVOIR, ELMIRA, N. Y.

sidered as furnishing the highest guarantee of absolute immunity from interruption of any form of water-works construction that has yet been devised. In the case of the cities of New York and Boston a demand for additional supplies has led, already, to the duplication of masonry aqueducts, but I venture a step further, and say that the interests to be conserved in a large town are so great as to frequently justify the additional expenditure for duplication in the beginning.

Since the publication of the paper in the November number the City of Brooklyn has afforded a practical example of the evils of an interrupted water-supply. The water-supply of Brooklyn is derived mostly from a series of slightly-elevated ponds, lying east of the city, the water of which is conveyed through a masonry aqueduct by gravity to a pumping-station and thence elevated by steam power to the distributing reservoirs. The growth of the city led to a demand for an increased supply, and the operation of

GRAVITY FIRE-STREAMS AT FREDONIA, N. Y.



FOUNTAIN AT WATER-WORKS RESERVOIR, ROCHESTER, N. Y.

[When discharging at daily capacity of 6,700,000 gallons.]

laying a forty-eight inch cast-iron main parallel to, and very near, the original masonry aqueduct was in process Saturday, November 21, 1891, when a break in the aqueduct caused an entire interruption of the flow for about forty-eight hours. The present daily consumption is 58,000,000 gallons, and at the time of the accident there were only about 83,000,000 gallons in store, or say thirty-four hours' supply. On Monday morning, November 23, this amount was depleted so seriously that the elevated railways and the Brooklyn-bridge cars stopped for want of water for their engines. All manufacturing establishments using steam, and business houses driving elevators by water, had been warned Sunday afternoon; wash-day was postponed, and in many private houses it was impossible to get a drop for any purpose. The break was, however, fully repaired on Monday, and by Tuesday morning enough water had been again forced into the reservoirs to allow the citizens of Brooklyn to resume their ordinary vocations.

The utility of gravity supplies may be illustrated further by referring to the opportunity which they afford for the formation of public parks at the large storage-reservoirs frequently required, or about the sources of supply when they are either large ponds or

moderate-sized lakes. This quality has been utilized in the Cochituate gravity supply at Boston, where considerable areas around Lake Cochituate are owned by the municipality and arranged with reference to permanent use for park purposes. At Chestnut Hill reservoir, in the outskirts of Boston, the Chestnut Hill Reservoir

FOUNTAIN AT WATER-WORKS RESERVOIR, ROCHESTER, N. Y.
[When discharging at daily capacity of 3,000,000 gallons.]

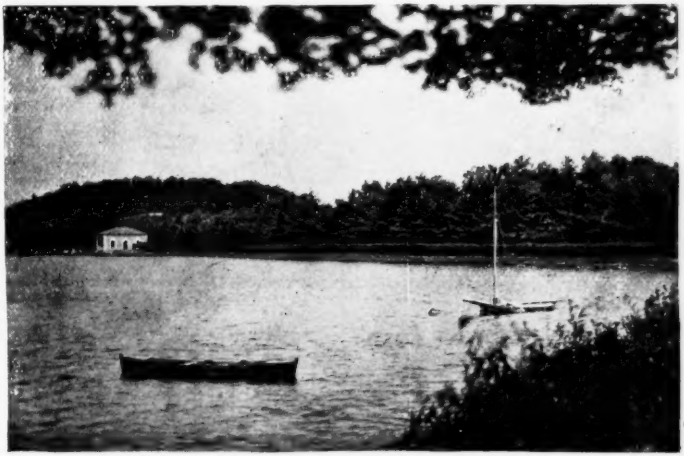
Park also affords a fine illustration of the utility of large storage-reservoirs as the point of interest about which to group an extensive development of surburban park. Such development, however, while contributing to the attractiveness of the locality, should be made with reference to maintaining the purity of the water-supply under all conditions. To this end human habitations and the usual wastes resulting therefrom should be kept scrupulously at some distance from the water's edge, or when located near thereto, only allowed under such regulations as will certainly maintain the purity of the stored waters. This is the theoretical conclusion, but it need hardly be said that the theoretical condition is often ex-

CHESTNUT HILL RESERVOIR, NEAR BOSTON.

ceedingly difficult to attain. In a paper on "Epidemics and Water Pollution," in the May (1891) number of this magazine, I stated that there is in the State of New York a special act under which, through the medium of the State Board of Health, the purity of water-supplies may be protected from the ordinary pollution due to the location of houses, barns, pigsties, privies, etc., too near either the shores of ponds, lakes and reservoirs or the banks of down-flowing tributary streams. The extension of similar provisions in the other States may be considered inevitable as public appreciation of the importance of thorough protection becomes more general.

In a few foreign cities gravity supplies have been utilized for

large fountains at distributing- or receiving-reservoirs, and in this country there are two notable examples of such fountains, which may be described here briefly. The first of these, and the first of the kind in this country so far as the writer is informed, is at Elmira, New York, where a distributing-reservoir 250 feet square is connected with a large storage-reservoir by a twelve-inch main 4500 feet in length. The bottom of the storage-reservoir is 110 feet above the nozzle of the fountain, and when filled to its maximum depth of 34 feet the water surface is 144 feet above the nozzle. This storage-reservoir is situated on a mountain stream which frequently becomes dry in summer, and a storage capacity



ON LAKE COCHITUATE, NEAR BOSTON.

of 113,000,000 gallons is accordingly provided as a contingency against the dry period. The height of water in the storage-reservoir may be stated therefore as varying from about 115 feet above the nozzle to 144 feet. The large central jet of the nozzle is four inches in diameter, and with water surface in the storage-reservoir at an elevation of from 130 to 140 feet, and with still or nearly still air, the central jet rises to about seventy feet above the nozzle. There are 132 side jets each one-eighth of an inch in diameter. This fountain was first operated in 1870.*

* Information communicated by J. M. Diver, Esq., Superintendent Elmira Water-Works, in a private letter to the writer.

GENERAL VIEW OF HEMLOCK LAKE.

At Rochester, New York, a similar fountain was constructed in 1874–75 and first operated in 1876. At this place the normal water surface of the storage reservoir from which the pressure is derived is about 110 feet above the central jet. For the nozzle a large number of different-sized jets are provided, and when discharging, as indicated in the illustration with the high jet, probably 3,000,000 to 3,500,000 gallons a day passes. When discharging, as illustrated with the low jet, the quantity passing through the nozzles is about 6,700,000 gallons per day as determined by measurements made in the summer of 1890.

In reference to these large fountains it must be stated that aside from their value as the nuclei of park decoration, they are of considerable use for aerating water before sending it to the consumer. All impounded waters suffer at times from markedly unpleasant tastes and odors, due to the abnormal development of cryptogamic life. These may usually be mostly removed by aeration through such a fountain.

On August 24, 1890, a measurement was made of the height to which a single three-inch central jet would rise from the Rochester fountain, the result being that the solid column of water rose to within thirty feet of the water surface in the storage-reservoir. The main connecting the distributing- with the storage-reservoir is twenty-four inches in diameter and about 46,800 feet in length, and

AT THE FOOT OF HEMLOCK LAKE, CHIEF SOURCE OF WATER-SUPPLY, ROCHESTER, N. Y.

under the existing conditions the delivery was at the rate, approximately, of 2,200,000 to 2,300,000 gallons in twenty-four hours. While this flow was in progress a pressure-gage attached to the main delivery-pipe, a short distance from the nozzle, showed a pressure of forty-six pounds; before starting the fountain and with no water at all passing the same gage showed a pressure of a trifle over fifty-one pounds.

These several facts lead to the consideration of a number of points wherein the hydraulics of a gravity-pressure conduit differ from those of the force-main of a pumping-system, which we may

AT THE HEAD OF HEMLOCK LAKE.

now briefly discuss, our illustrative examples, so far as any are needed, being drawn from the twenty-four-inch gravity main of the Rochester water-works, between the storage-reservoir at Rush and the distributing-reservoir at Mt. Hope. As already stated, this main is twenty-four inches in diameter and about 46,800 feet in length. The difference in elevation between the normal water-surfaces of the two reservoirs is 117.4 feet. The pressure-gage is 6.4 feet below the normal water-surface at the Mt. Hope distributing reservoir, or 123.8 feet below the normal surface for full reser-

CANADICE VALLEY, NEAR ROCHESTER, N. Y.

voir at Rush. With the gates at Mt. Hope closed tightly this pressure-gage indicates a pressure due to the elevation of the water-surface at Rush—or for full reservoir—53.5 pounds, which we

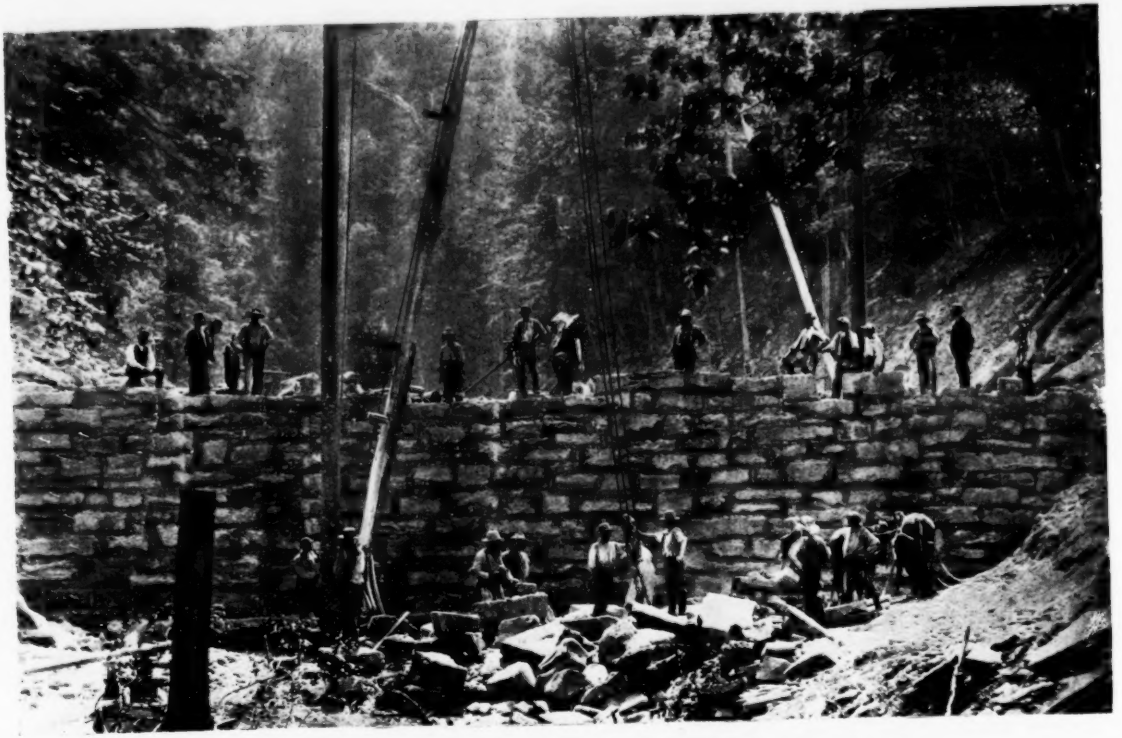
FOOT OF CANADICE LAKE.

may for convenience call 53 pounds. If the stop-gates at Mt. Hope are opened gradually the number of pounds indicated by the pressure-gage will become less as the opening increases until finally the pressure-gage will show a pressure of only about three pounds, and when this latter condition is reached, the conduit between the two reservoirs is discharging at full capacity ; that is to say, all the water is passing through it that can pass with the stated conditions, under the influence of gravity.

In the case of a force-main we have seen in the previous article that an increase in the power expended might enable us to increase the delivery considerably beyond the limit of economical operation. With a given gravity main, however, no such increase is possible. The gravity delivery is fixed by unalterable natural laws, the operation of which we will examine a little in detail. The two chief laws of friction in relation to velocity and length have been cited in a previous paper and no further reference to them need be made other than to state that their application to a gravity conduit is essentially the same as to force-mains, that is to say : (1) with a given diameter of main, doubling the velocity will increase the frictional resistance four times ; while (2) with a given diameter and velocity, doubling the length increases the friction two times.

The general law of gravitation applying to the specific case in hand is that *the theoretical velocity of a freely falling body, is, at any given point in the descent, equal to the square root of twice the acceleration of gravity into the height through which the body falls.* In a gravity-conduit we have therefore two forces in opposition, and the final resultant, which may be considered as the balancing of these forces, is represented by the work accomplished in delivering water through the main. These forces are (1) gravity, which, by itself, would produce a uniformly-accelerated velocity up to the limit of vertical height between the two water surfaces, and (2) friction, which tends constantly to retard gravity, in accordance with the two laws previously stated. All these points and some others in reference to stored energy are fully illustrated by the throw of the fountain jet in conjunction with a given delivery for a given height of throw.

By way of making the last statement clear, I may call attention to the general hydrostatic proposition that water seeks its own level. This may be taken as meaning that in a U-shaped tube water will stand at the same height in the two legs. It may be taken as meaning also, that our fountain jet, independent of the



BUILDING A MASONRY DAM FOR A STORAGE RESERVOIR IN A DEEP RAVINE, FREDONIA, N. Y.

retarding influence of (1) friction in the main between storage-reservoir and point of discharge; (2) friction in the nozzle, and (3) friction of the air, will rise to the height of the source of supply. In the measurement of August 24, 1890, the distance of thirty feet of the top of the solid jet below the water surface of the storage-reservoir, may be taken as measuring all these various sources of resistance. If in any way the several retarding influences could be eliminated the jet would rise by virtue of the stored energy to the same height as the original source.

It has been stated already that a reading of 46 pounds of the Mt. Hope pressure-gage on August 24, 1890, indicated a daily delivery of about 2,250,000 gallons. At that time the water-surface

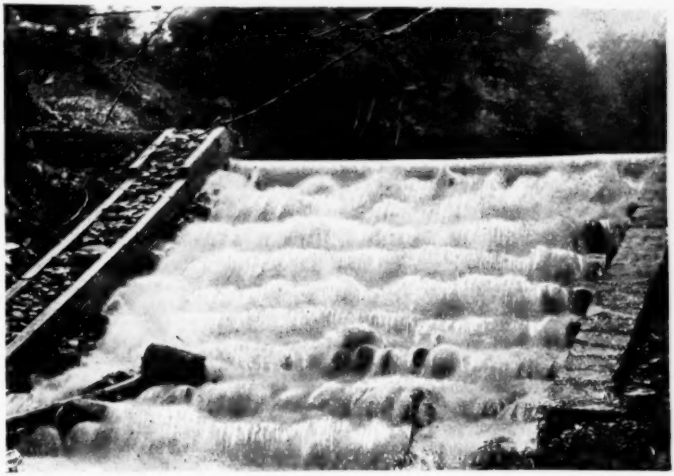
THE DAM AS COMPLETED.

at Rush storage-reservoir was something like five feet below normal, and, if we reckon from normal, we have the following approximate daily deliveries for the several readings of the pressure gage: For a reading of 40 pounds, a daily delivery of 4,250,000 gallons; for 30 pounds, a delivery of 5,600,000 gallons; 20 pounds, 6,700,000 gallons; 10 pounds, 7,600,000 gallons; and for 3 pounds, a daily delivery of 8,200,000 gallons, which may be considered the approximate full capacity of this particular conduit.

On taking a brief retrospect it is seen that these several increases in daily delivery are accompanied necessarily by an increase in velocity of the flowing stream, until finally, the daily

delivery of 8,200,000 gallons represents the point where the gradual increase in friction, by reason of increase of velocity, just balances the accelerating tendency of gravity. When this latter condition is reached the fountain jet will not throw at all; the delivery of the maximum possible daily quantity can take place only through practically the full area of the conduit and at the water surface of the lower reservoir. As a matter of fact a separate discharge-well, involving the application of these conditions, is provided for use whenever it is necessary to utilize the full discharging capacity of the conduit.

There is another law of friction which may be considered of



ANOTHER VIEW OF COMPLETED DAM.

importance in designing the main conduits for gravity water supplies, namely, that *for a given delivery the relative friction in two conduits of the same length but of different diameters will be nearly inversely as the fifth powers of the diameters.* Thus we have a known element of friction in our illustrative twenty-four-inch conduit 46,800 feet in length; we will assume that a conduit thirty-six inches in diameter is to be substituted in place of it, and we desire to know the amount of friction in the new conduit for a given discharge in comparison with the old. The fifth power of 2, the diameter of the one conduit in feet, is 32; the fifth power of 3, the

diameter of the other in feet, is 243; whence, for a given delivery in the twenty-four-inch conduit, the friction therein is to the friction for the same delivery in the thirty-six-inch conduit, as 243 is to 32, or the friction for a given delivery in the twenty-four-inch conduit is about 7.5 times as great as for the same delivery in a thirty-six-inch conduit. A rational application of this law assists greatly in so proportioning gravity pressure conduits as to insure a due balance of reserve head for fire and other special purposes in those cases where sudden and relatively great demands may be made upon a water system for a short time.

As a typical gravity supply we may discuss briefly some further points in relation to the Hemlock Lake domestic supply of the city of Rochester. Hemlock Lake is distant from the center of the city about 29.2 miles, along the conduit line, and the mean water surface is 385.6 feet above the coping of the Erie Canal Aqueduct in that city. The lake is between six and seven miles long, nearly three-quarters of a mile wide and about ninety feet in greatest depth. The project of obtaining a domestic supply by gravity therefrom was first formulated definitely in a report made in 1860, when the population of Rochester was only 46,204. The proposing at that time of a gravity conduit of the length of this one may be considered a bold prophecy of the possibilities of the city's growth, but its justness is proved by the fact that in 1890 the population had increased to 133,896. The conduit proposed in 1860 was to be sixteen inches in diameter, with an estimated daily capacity of 2,000,000 gallons. The conduit actually constructed in 1874–75 is thirty-six inches in diameter for the first ten miles and twenty-four inches for the remainder of the way. Its capacity between the lake and the storage reservoir, 19.2 miles distant therefrom, was found to be 6,700,000 gallons daily in 1890; between the storage reservoir and the distributing reservoir at Mt. Hope its capacity is as already stated about 8,200,000 gallons a day. It may be noted as a matter of interest that, taking into account length and size of pipe, this Rochester conduit is one of the large pipe-lines of the present day. In addition to Hemlock Lake, the water-supply of the city of Rochester may be considered as also derived from Canadice Lake, which lies two miles east of Hemlock and 200 feet above it.

The foregoing brief discussion may be taken as presenting a very few of the points to be considered in designing a gravity-pressure water-supply for a large town. Precisely the same con-

siderations will be involved in the design of a similar supply for a small town, the only difference being in the quantities to be dealt with. No attempt is made to indicate the processes by which an engineer arrives at his conclusions. Such processes are essentially technical and would have little interest in a popular discussion, where all that can be attempted is a presentation of leading principles.

By way of illustrating the features of a gravity supply for a medium-sized town, some illustrations are given pertaining to the water-supply of the village of Fredonia, New York, constructed in 1884. At this place the reservoir is three and one-half miles distant from the town and 240 feet above the main portion. It is formed by a stone dam twenty-five feet high across a mountain stream, flowing through a deep rocky gorge, and made to approximate ideal conditions by stripping the vegetable mold and soil from the rock to above the water line, leaving the close-textured shale rock at the sides and bottom nearly clean. The depth of twenty-five feet at the dam, together with the protection of the heavy forest at the sides, gives the assurance that cool water may always be drawn from the lower strata, and to this end the arrangements at the outlet-well permit of drawing at different depths. The population of the village is 3000 and the provision is sufficient for supplying 5000 people each with 100 gallons per day, and still retain a reserve pressure of 50 pounds per square inch for six fire-streams, when all are in actual use. To produce this result a twelve-inch pressure conduit was designed. The minimum discharge of the stream as gaged in long-continued dry weather in 1883 was about 250,000 gallons per day, which, with a moderate contingency allowance, indicated a storage of from 9,000,000 to 10,000,000 gallons, and this amount was provided accordingly in the rocky gorge as indicated by the illustrations. The Fredonia water-supply may be considered as illustrative of the better class of village supplies.

SUGGESTIONS TOWARD HUMAN FLIGHT.

*By Hyland C. Kirk, M. E.**

AERIAL navigation as a practical problem awaits solution. There are many reasons why it should possess an interest for reasonable minds. Were such navigation even less practicable, the idea of moving through space without dependence upon roadways or bridges, while enjoying without restriction the health-giving atmosphere, might well charm the imagination. But human flight is purely a mechanical problem not apparently more difficult than others which have been mastered by modern inventive genius seemed at their inception. Why then may not the trained mechanician seriously consider its solution? Three eminent authorities—Mr. Octave Chanute in this magazine and Messrs. Langley and Maxim in the *Century*—have so recently presented papers on this topic that the present contribution would scarcely have been offered but for the suggestion, by certain engineers acquainted with the writer's penchant, that some proposed plans of his might be of additional value and interest to the public.

No important invention has ever been consummated in a single effort, but only as the result of repeated trials and usually by different individuals. Yet it is probable that if all the mechanical elements contributing to the success of the locomotive or the steamship had been carefully studied and tested at the outset, success might have been attained in either branch of invention much sooner. As Horace Greeley suggested of the way to resume specie payments, the way to build an aeromotor is to go to work and build it. But the difficulty in the way is the lack of trustworthy data bearing upon the problems to be met. A mechanism is required of such power in relation to size or weight, and so adroitly proportioned, that the inventor who would succeed must possess a complete knowledge of every element likely to be needed. The aeronautic engineer, M. Nadar, has said in this connection—

* Copyright, 1892, by Hyland C. Kirk.

"All that is not absurd is possible;
All that is possible may be accomplished."

It is assumed here that a successful aeromotor should have power (1) to raise and support itself in the air; (2) to move forward in any desired direction, maintaining the same horizontal plane; (3) to preserve a due equipose and steadiness of motion; (4) to enable the momentum of the apparatus to be increased at the will of the operator so as to withstand counter-currents of air, and (5) to secure safety in alighting upon the ground or in the water.

It is not probable that the construction of an aeromotor embodying these essentials will be accomplished by simply preparing a design on paper, or in building from some plan the details of which are chiefly dependent upon the projector's imaginative powers. This has been the difficulty with a thousand or more unsuccessful attempts. Obviously the principles ought to be selected which such a machine may involve in its structure, and tested by careful experiment, until we have the data necessary to construct a working apparatus. Such a machine must involve some of the following six principles in its construction:

I. The principle of dual support. While there is no more reason, probably, for constructing an aerial machine in the shape of a bird than there is for building a locomotive like a horse, yet certain general principles of flight cannot be ignored. A bird cannot fly with one wing, and any apparatus which possesses sufficient steadiness to ensure safety to its occupants must have a stable equilibrium. Hence the necessity of dual support with the center of gravity as nearly as possible between and below the two floats, planes or other supporting bodies.

II. The aeroplane or kite principle. This is important for guiding and in some measure supporting the motor, since by this principle many birds are enabled to float in the air without apparent wing-motion. The albatross, it is asserted by sailors, even sleeps on the wing. This was the chief principle embodied in Henson's aerial-carriage and in the machine which won for Mr. Stringfellow the hundred-guinea prize offered by the Aeronautical Society at the London Exhibition in 1868.

III. The principle of the propeller-screw. As early as 1768 a French engineer, M. Paucton, predicted for the screw, which penetrates the air as a gimlet bores wood, its future importance in aerial navigation. This view was shown to be correct by the demonstra-

tions of M. Nadar and the working models of MM. Ponton d'Amecourt and de la Landelle. However, it seems not to have occurred to these gentlemen that in rising into the air, the screw-device requires a greater expenditure of force to propel it than a device would which should exert a downward striking movement like that of the wing of a bird. But since there is no reaction of the air retarding the screw-movement it is evidently an incomparable device for forward propulsion. Where two parallel screws rotate in opposite directions as shown in Figure 1, there is a great gain in resistance, because one utilizes the current of the other.

IV. The principle of aerostation involved in floating bodies. Balloons are rightly termed "aerostats," because they *stand* subject to the influence of the air and are but slightly in advance of the soap-bubble toward the successful solution of aero-dynamics. Yet for purposes of observation and experiment the balloon has proved valuable, and as the problem involves vertical as well as forward motion, it is not unlikely that aerostats may be found of great value at stations for elevating passengers and freight or even for uplifting aeromotors preparatory to flight.

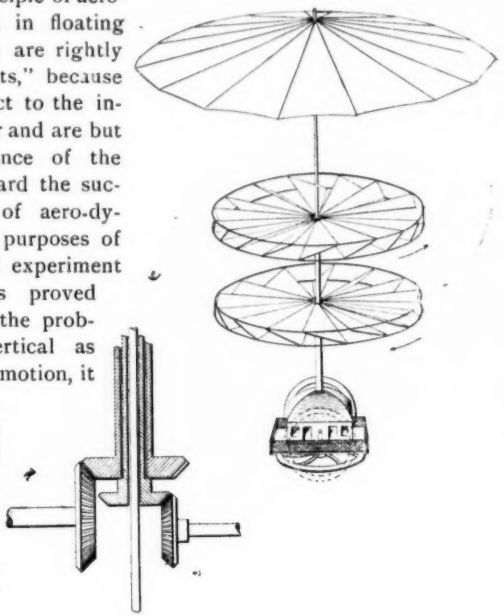


FIG. 1.

V. The principle of recoil and unequal pressure as displayed in gunnery, Barker's mill and other mechanisms. This principle, by which the cuttle-fish propels itself and sky-rockets ascend, has been applied in various ways to aerial locomotion and perhaps with little show of success if we except Jules Verne's trip to the

moon. However, M. Trouvé regards the explosive motor as the base of the future flying-machine, and the power which compressed air is known to possess suggests that this principle may yet prove valuable. Some years ago the writer experimented on what he termed the aero-reaction-screw, which consisted of a number of screw-blades rotating on a shaft and propelled by the unequal pressure of air issuing from pipes attached to the shaft at an angle opposite the direction of motion, and severally striking the under side of the nearest propeller-blade. Preferably such a screw should have the tubes located within the blades themselves, thus lessening friction. A model of this kind four inches across the blades worked perfectly, the pressure of the breath serving to send it up some distance into the air. The design was to attach a number of such screws, some horizontally and some vertically, to an air-tight flat box constituting an aeroplane within which a third plane surface acting as a piston should constantly force the air into the reaction-screws. The piston-plane was to be elevated by levers or springs, and depressed by the weight of the operator.

VI. The principle involved in rotating bodies at high rates of velocity tending under certain conditions to preserve their planes of rotation and also under certain conditions to increase the momentum of their forward movements. This principle has had two successful applications in practical mechanics—in the case of the balance-wheel to equalize motion and in the rotary movement of rifled projectiles, the latter being the most perfect application of the principle known. It was on this principle that Foucault's celebrated experiment with the gyroscope, [see Figure 2] demonstrating the diurnal motion of the earth, was made. A disk or globe made to revolve rapidly in any plane tends to remain revolving in that plane by an amount of force proportionate to its weight and velocity. In the gyroscope, where the revolving disk is made constantly to change its plane in spite of this tendency to preserve it, the resultant force is seen to be sufficient to support a heavy disk in mid-air.

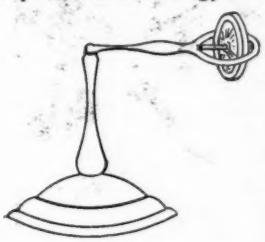
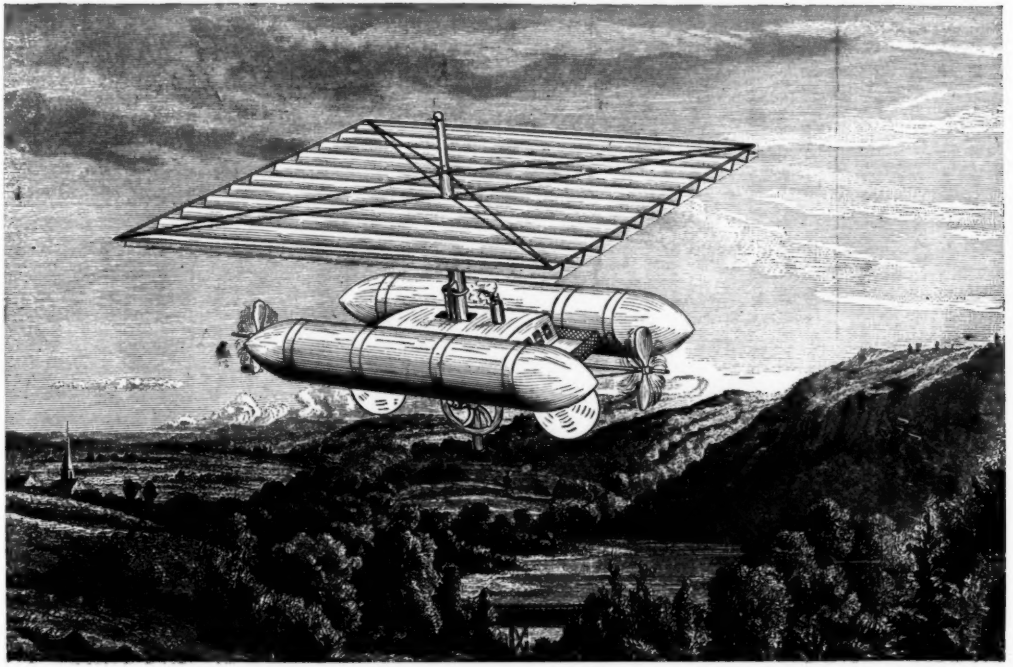


FIG. 2.

Mr. Bessemer, the English inventor, in 1874 made a trial of this principle in the application of a heavy and rapidly-revolving wheel, to a free-supported cabin on a channel steamship, for the purpose



AEROMOTOR WITH WORKING PARACHUTE,

of rendering it steady by offsetting the motion of the waves. Mr. E. J. Reed, C. B., M. P., reporting on the trial trip before the Institution of Naval Architects, in 1875, said: "The sea was rough enough to induce large vessels to lift their fore-feet quite out of the water and to plunge their fore-castles under water; but at that moment the pitching motion of the *Bessemer* was almost *nil.* * * * My own feeling is that it is extremely likely that one of the applications of this principle, which, I believe, will be perfectly successful in every point of view, will be its application to small cabins."

Though such a rapidly-rotating body yields to gradual and constant forces, it resists sudden impulses vigorously, and so tends to preserve the equilibrium and direction of any free-moving apparatus to which it is attached. The advantage of applying this principle to a vessel moving in the air, over applying it to a vessel moving in two fluids subject to the powerful action of the waves, will be apparent, and it may be remarked that four years before Mr. Bessemer's experiment the writer filed a caveat on a proposed aeromotor involving this same principle. It is believed that by preserving the direction of motion the forward movement will be aided, especially when screws or other devices are attached to utilize the momentum.

The question of power remains to be discussed. It is probable that some men have muscular energy enough to fly if it could only be applied to the best advantage, though within recent years no arrangement of wings or other mechanism has availed for that purpose. The small-size Siemens dynamo used by Victor Tatin for aerial purposes, with four electro-magnets, weighed 120 pounds and could deliver one hundred kilogram-meters. Naphtha-engines may be made very light in proportion to their power; but probably all motors are surpassed in this respect by Mr. Maxim's compound steam engines of 300 horse-power and with a weight of but 950 pounds. As the motor has to be adapted especially to each apparatus, let us notice a few plans presented as working hypotheses for purposes of experiment.

PLAN A.

First will be cited a plan requiring that the air shall be comparatively still. With this it is contemplated that human muscle, steam or electricity may be used as motive power. Figure 3 is a side elevation; Figure 4 a plan view, and Figure 5 a section.

In this plan two equal floats, filled with gas, sustain between them by means of a simple carriage and stays a resistance-disk or drive-wheel, geared to a horizontal rotating-shaft having attached to it one or more propelling-screws. A horizontal steering-plane,

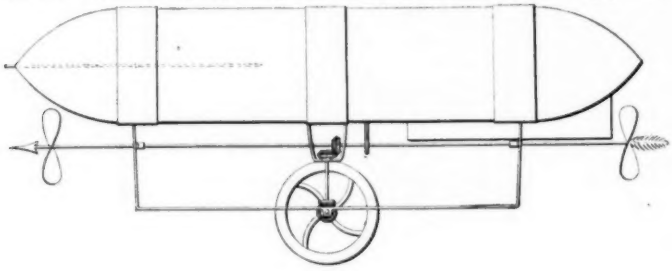


FIG. 3.

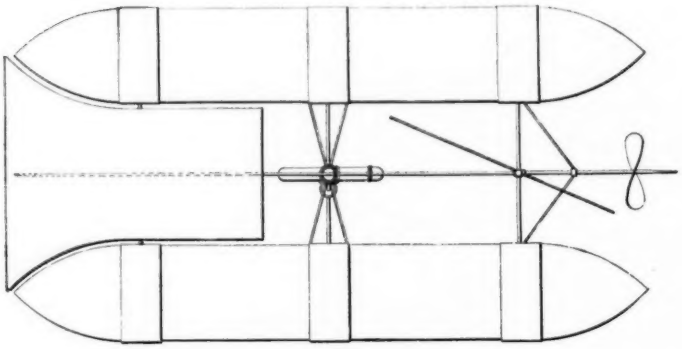


FIG. 4.

used in ascending, is supported aeronaut by piving-plane used in right or left from the middle ing-bars in rear of the representing an appasingle aeronaut, contemfloats about ten feet in dred feet in extent, with when three-fourths filled pounds. The floats are

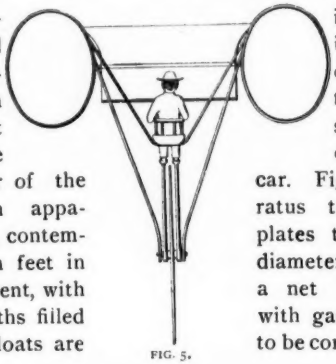


FIG. 5.

ing or descendin front of the ots, and a steerturning to the swings vertically of two connectcar. Figures 3, 4 and 5, ratus to carry but a plates the use of two diameter and one huna net buoyant power, with gas, of about 200 to be constructed of light

flexible rods extending lengthwise and held at each end by suitable end pieces made of aluminum or other material; this skeleton to be covered with India, tusser or pongee silk, and four light coatings of balloon varnish applied to make it impervious and durable. Each float is made so large that it need not be filled more than two-thirds or three-fourths full to secure the requisite buoyancy on the ground, thus allowing for expansion of the gas when the machine is elevated. The floats are surrounded by net-work attaching them securely to three bands, made preferably of aluminum, from which the car and machinery are suspended.

As the volume and consequent buoyancy of aerial floats increases as the cubes of their like dimensions, while their surfaces increase as the squares only, there is an advantage so far as relative buoyancy is concerned in making them as large as the strength of materials, manageability and other limitations will permit; but a corresponding disadvantage in the increased resistance of the air. If we make use of floats, then a mechanical mean between these elements must evidently be sought. Suppose that metal cylinders are used, with barely enough buoyancy to raise them or the apparatus to which they are attached, and depend upon special appliances for the general management of the apparatus. The full-page illustration represents such a device propelled by steam. The parachute-canopy attached is adjustable on its supporting post to any angle desired, and is made up of air-valves which are operated to elevate and propel the machine or to resist adverse currents. The general character of these valves will be considered in connection with another device.

PLAN B.

This contemplates the use of four hollow globes after Father Lana's idea, exhausted in some degree of air and rotated upon their axes. It is not supposed that these globes will sustain the apparatus or even themselves. Weight and motion are however, the essential elements of flight and it is believed that the rapid rotation of these globes, suitably attached to planes, propeller screws or other sustaining devices, will tend to increase the momentum and sustaining power of the whole,—at least the plan is deemed worthy of experiment. Steam is designed as the motive power, but the pneumatic piston attached to the sides as shown in the drawing is presented as a means of sustaining and propelling the apparatus. This piston, supposed to be not less than twenty

feet in diameter and proportionately deep working simply in the air, illustrates the principle of unequal pressure. In proportion to its dimensions, force, rapidity of stroke, and size of valve-openings,

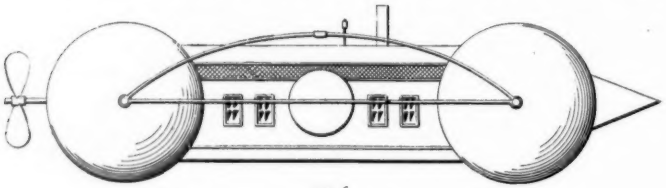


FIG. 6.

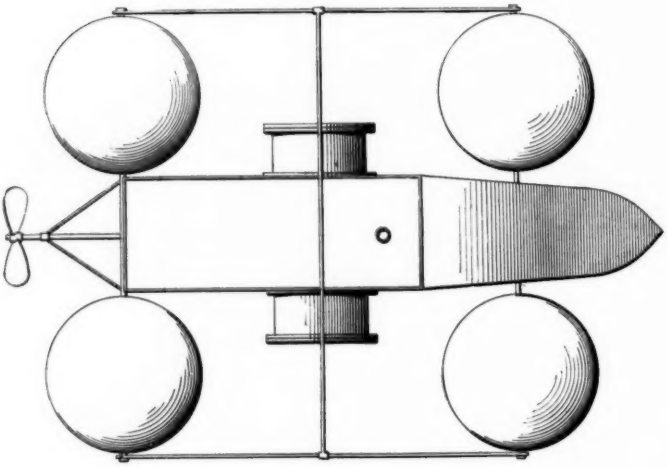


FIG. 7.

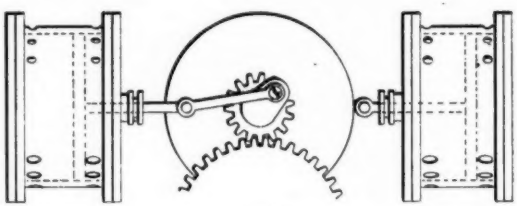


FIG. 8.

will it tend to lift and propel the apparatus in the direction opposite to the valve-openings? These valve-openings are supposed to be very much larger than represented in the figure. Figure 6 repre-

sents a side elevation ; 7, a plan of the apparatus, and 8 the pneumatic piston in detail.

PLAN C.

This form of apparatus is deemed important as a means of testing the power of propeller-screws and the elevating power of stretched canvas acting on the kite principle. It contemplates the attachment of propeller-

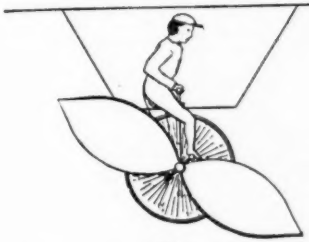


FIG. 9.

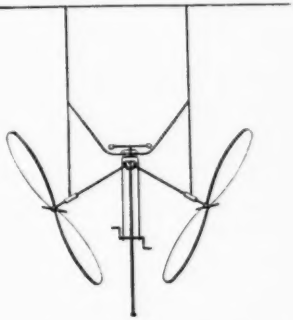


FIG. 10.

screws to a bicycle or other wheeled vehicle where the impetus for flight is acquired on the ground. Such screws are intended to represent the principal of dual support to the apparatus, and are to be supplemented by the use of an adjust-

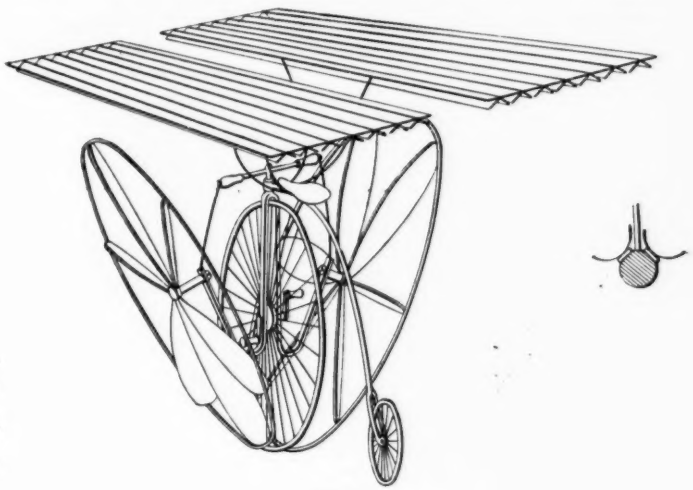
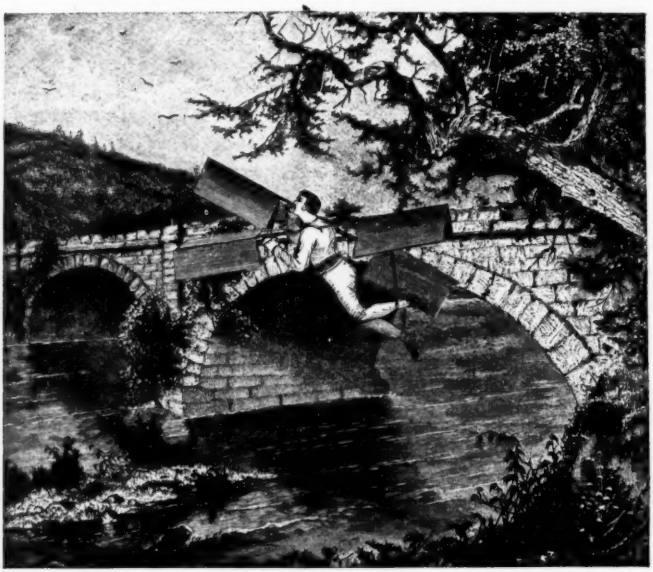


FIG. 11.



BESNIER CROSSING A STREAM.

able canopy acting on the kite principle. With a bicycle as the propelling wheel, the screws within a simple circular rim may be attached at any angle, either with friction-gearing or otherwise, as may be found most practicable and effective for the purpose. Figure 9 is a side elevation of the apparatus; 10, a sectional view; 11, a modified form; 12, a sectional view of apparatus having two sets of propeller-screws attached, and 13 a view in perspective of the same.

PLAN D.

Finally, as the apparatus which in some modified form is most likely to become the successful flying-machine pure and simple, because approximating most closely to the movements of flying creatures, and also being adjustable to machinery and human control, is a device in its general outline involving two or more planes working more or less vertically, which approach and recede from each other in such a way that this alternate movement not only lifts but also aids the propulsion of the apparatus. Each plane is made up of automatic air-valves, which close as the plane descends. Such planes are represented by *a*, *b*, in Figures 14 and 15.

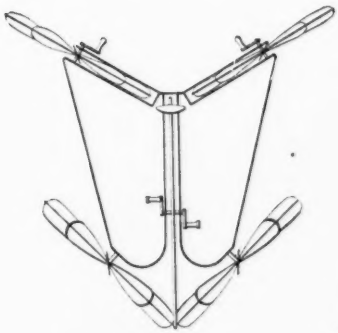


FIG. 12.

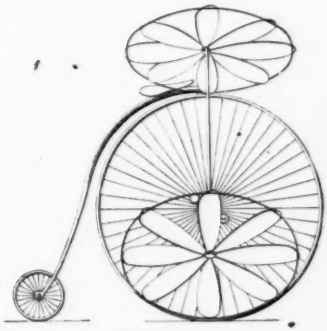


FIG. 13.

These self-acting air-valves are made after the famous device of Besnier of the Province of Maine, who in September, 1678, succeeded in raising himself from one height to another until he reached the top of a house. He also crossed from one house to another, and if we may believe the account, flew over a river of con-

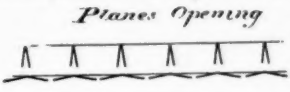


FIG. 14.

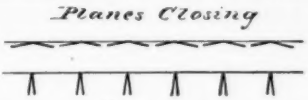


FIG. 15.

siderable breadth. A purchaser of his first pair of wings, Mr. Baldwin, of Guibre, used them, it is also said, with remarkable success. In the proposed arrangement of planes containing these

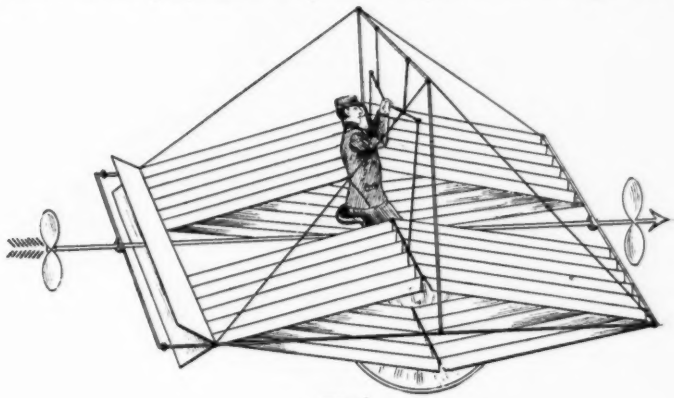


FIG. 16.

valves, one of the most practicable forms is that of a double-collapsible hinge figure.

The most difficult feature in flying is the initial movement—rising from the earth. The resistance and consequent ability to rise increases as the square of any striking force employed, while with such devices as the screw which do not strike the air, it increases in the direct ratio merely of the velocity. Then again the bird gains to some extent by the upward as well as downward stroke, the ascending wing utilizing the current created by the wing descending and *vice versa*. So in this motor the valves in the upper planes present a solid surface in descending, while at the same time the valves in the lower planes rising are open to the free passage of the air. Conversely the valves of the lower planes present a solid surface descending, while those of the upper are open to the free passage of the air. Consequently there is one set of planes striking the air constantly and each utilizing the current to some extent made by the other.

It is believed that the valves may be so arranged in this motor, either lengthwise or at right angles to the framework, as to strike the air downward and forward at each stroke, thus in another respect resembling the wing-stroke of the bird.

In the practical working of this apparatus each set of collapsible hinges—of which there are at least two to each complete machine—is arranged to open and close, *i. e.*, rise and fall by sliding or rolling on bars constituting the frame-work on each side of the apparatus. As arranged in the cut, the front end of the hinges is permanently fixed, so the sliding movement all occurs at the rear

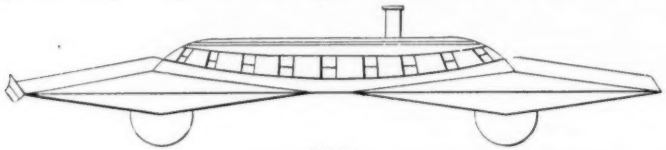
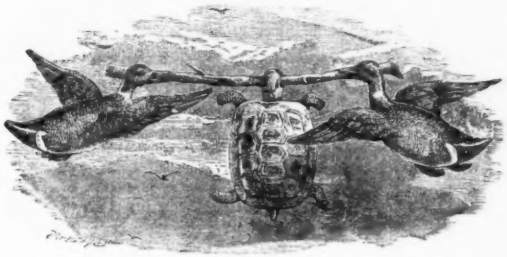


FIG. 17.

end of the apparatus. Along with this movement a pair of hinged valves extending across the entire rear part is made to open and close, serving half the time as a propelling force. If man-power should prove available, an individual may use his weight, hands and feet, as shown in the figure (16) for propelling such a machine. Figure 17 shows a form of the apparatus where steam or electricity is used as motive power.

Of the plans suggested in this paper it is believed that the

most valuable features of each may be embodied in one apparatus for the purpose desired. It is believed that on the lines suggested and probably from these immediate devices a successful aeromotor can be built ; and now when so many engineers are unemployed—without money and without price, as it were—would appear to be a suitable time to do it. When systems of rapid transit are being considered the possibilities in aeronautics should not be ignored. If both engineers and capitalists should become interested in this matter, the World's Fair might yet exhibit a creditable aero motor.



GOVERNMENT ENGINEERING DEFENDED.

By Lieut.-Colonel W. R. King,

United States Corps of Engineers.

"IMPORTANT!—if true" was the ingenious phrase of the festive War Correspondent during "the late unpleasantness," designed to catch the reader's eye and lead him through "a bald and unconvincing narrative" that lacked but a few facts in place of "ifs" and "buts" to make a reliable statement of the condition of affairs. A careful reading of Mr. Wisner's paper on "Worthless Government Engineering" in the January number of this magazine suggests that this would have been a very appropriate heading for his romance. There are so many reckless misstatements in this arraignment of the Corps of Engineers, and the specifications are often so vague and indefinite as to time, place and person, that it is practically impossible to untangle the web and correct each individual error; but many of the salient points may be corrected without, I trust, encroaching upon the reader's patience, and in so doing, I shall endeavor to use no argument or language that will not be readily approved by the great body of engineers and other intelligent readers who will take the trouble to inquire into the merits of the case.

The statement that "the officers of the Corps admit that the works they have designed and undertaken to construct in a majority of cases have failed to produce any beneficial results," like an overdose of any other poison, will not only void itself but carry with it matters that by themselves would be comparatively harmless. The country is full of works like the Delaware Breakwater, Hudson-River and East-River improvements, New York harbor, Buffalo, Chicago and other Lake harbors that have been created or improved; the removal of Blossom Rock, the Des Moines, St. Mary's and Louisville canals, Lake, Boundary and Territorial surveys, Light-houses and public buildings, that have not only been skillfully, successfully and economically executed by the Corps of Engineers, but are so recognized by all intelligent and disinterested persons

The officers admit that they have made mistakes, and if we can believe Mr. Ingersoll, even Moses did; but where is the engineer who has had a chance and yet has not made a mistake? In fact, is

it not true that the greatest engineers have made the greatest mistakes? The blackest kind of spots can be found on the sun if one will only hunt for them with a powerful telescope. Did not John Ericsson invent a caloric ship that was a total failure and a plan for propelling torpedoes that he found utterly impracticable? Did not Sir Henry Bessemer build an anti-seasick steamer that failed, and a gun that has hardly been heard from? Did not Robert Fulton fail in his attempt to sink a ship by torpedoes, and did not Mr. Stevens fail to carry out his plans for a floating battery, although two or three millions were expended on it? Did not Sir Isaac Newton set astronomy back fifty years by *proving* that a large refracting telescope was impossible? To come nearer home, is it not a fact that the great St. Louis bridge cost two or three times as much as a suitable bridge should have cost, besides being a great and unwarranted obstruction to navigation? But it is not necessary to multiply instances to show the possibility of engineering failures. The terrible bridge accidents at Hamilton, Ashtabula, Revere, the Firth of Tay and elsewhere are too well known to require statement.

But let us look at the specific charges of failure as stated by Mr. Wisner, which, since he has had fifteen or twenty years to hunt up these charges, we may infer are the best he can make. They are Charleston and Galveston harbors. Of the former he says:

"According to the latest charts the average depth of water on the bar is approximately the same as in 1878. Since jetties, however far completed, should produce the same effect through section of channel between them as when carried to any greater distance seaward, it is evident that to continue the work under the present plans will be a deliberate waste of public funds."

This statement might have had some bearing on the case if the two jetties had been built continuously from the shore to the bar, but in this case it was necessary to leave a ship channel through the south jetty until the jetties were so far advanced as to maintain a navigable channel and allow the old channel to be closed. This has been partially done during the past year, since the report to which Mr. Wisner refers was made, and the result is that a vast quantity of sediment has been scoured out and the channel is evidently working its way through the bar. That the work will cost more than was originally estimated is true, but it should have been built in *four* years instead of *fourteen*, and any intelligent engineer knows what that means.

A similar state of things exists at Galveston, and at both of these

harbors the difficulties to be overcome are vastly greater than those at the mouth of the Mississippi, where a large flow of fresh water makes it possible to use brush mattresses and furnishes an efficient current to scour out the channel when once directed by the jetties. At Charleston and Galveston the salt water flows back and forth with the tides, and the jetties must be far enough apart not to obstruct the inflow of the flood tide, while at the same time they should contract the channel so as to cause the ebb tide to do the scouring. These conditions are opposing and difficult to balance and, besides, it has been found that the use of brush mattresses is almost prohibited by the ravages of the ship-worm. Mr. Wisner continues :

"Captain Eads, at the request of the citizens of Galveston, made an examination of the harbor, and offered to enter into a contract to obtain a permanent thirty-foot channel across the bar and guarantee results for the sum of $7,750,000. This project the Army Corps succeeded in defeating. They have since formulated a plan for the improvement, which they have estimated to cost $7,000,000, but which, under the contract recently let, will require at least $9,000,000."

This opens a discussion that would far exceed the limits of this paper, and I would recommend any one who feels an interest in the subject, and has not already done so, to read the discussion of it in the Transactions of the American Society of Civil Engineers for 1886, especially a clear and impartial statement of the case by Mr. Octave Chanute, now President of the Society. For the present purposes it will only be necessary to invite attention to a few points bearing upon the merits of the question.

The original project of this harbor contemplated a depth of only eighteen feet and the works were designed accordingly. Owing to the great difficulty of obtaining stone, efforts were made to find a substitute and considerable money was expended in experimenting with brush and cement gabions, filled with sand and which promised well for a while, but which were found too light to stand the heavy storm waves of the Gulf. Considerable money was also expended for dredging, in the hope of giving a little temporary relief with the small appropriations, which were not large enough to justify any radical improvement. It may be added that the obstruction at Galveston consisted of an outer and inner bar, the latter being less formidable than the former and has been removed to a depth of twenty-one feet. The Corps of Engineers did not oppose Captain Eads's project as such, but they distinctly stated that if such a contract was to be made it should be open for other engineers and contractors to submit plans and bid on the work. The

evils of making contracts by special act of Congress are too apparent to require discussion. Other engineers did as a matter of fact inspect the locality at their own expense, with a view to bidding on the work, or submitting counter propositions to Congress. How could such bids be treated fairly by a legislative body? If one party had sufficient "pull" to get the contract, what would prevent his getting the terms modified subsequently, as Captain Eads did with his jetty contract? What would a guarantee of "no cure no pay" be worth in such a case?

While on this subject I wish to state distinctly that I never have been hostile to Captain Eads or his work. My intercourse with him, although limited, was of the most friendly character, and I was a firm believer in the jetty system for the Mississippi from the first. Although the method of making the contract was a dangerous and unusual departure from well-established custom, it was entirely within the discretion of Congress, and from the moment the act was approved all oppositions should have ceased, and Captain Eads should have had the earnest support of every agent of the Government. That this was not the case is beyond dispute, but it is equally true that many Engineer Officers did favor the jetty system, both officially and personally.

Generals Barnard, Alexander and Comstock favored the jetty system strongly, and it is a matter of history that as early as 1852, parallel jetties were proposed for this river by a Board consisting of Major Chase, Beauregard and Barnard, of the Engineers, and Commodore Latimer of the Navy. Here are five out of the small number of Engineer Officers who had any direct connection with the matter up to the time that Capt. Eads took hold of the work, who were in favor of jetties, and many others who had no opportunity for recording their opinions on the subject would have favored them had such opportunity occurred. Jetties have been in use on the harbors of the great Northern lakes for many years and have produced and maintained good navigation channels from 14 feet to 17 feet deep where there was practically no navigation before. Notwithstanding all that has been said and written about the antagonism of the Corps of Engineers to Captain Eads and his projects, I firmly believe that the effect of such opposition as he encountered was rather a help than a hindrance to the work on the South Pass. Captain Eads was a fighter "from way back," and a little controversy was not only keenly relished by him but acted as a stimulus to more vigorous effort.

So much for mistakes and failures. Let us now look at some of the charges of defective methods.

Mr. Wisner states that officers are so ignorant of their duties that they call in assistants and adopt their advice. If there is any more commendable course that such an officer could adopt I will be glad to have it pointed out. No higher compliment could be paid such officers than the statement that instead of pretending to *know it all* and snubbing assistants who presume to give them advice, they adopted the assistants' plans without a murmur. This little incident also tends to show that the talk about the arrogance induced by a military education is at least overstated. I once served on the staff of a railroad conductor who had become a Brigadier-General of Volunteers, and a very good one he was. During a little skirmish an officer rode up and stated that the enemy was up to some trick or other, and mildly suggested a remedy; but he was promptly withered by the remark: "Keep your advice until called for." Verily the martinet and military satrap, when they compete with the average railway magnate must "pale their ineffectual fires."

Another case is cited of a young officer, name not given, who "spent weeks determining the volume of discharge of a river and then corrected the result 20 per cent. from information given by citizens as to stage of water in former years." Having neither time nor data for tracing up this case I will only state that it is perfectly easy to reconcile this conduct with approved methods. If the officer was required to find the maximum discharge of the stream, which might not occur oftener than once in ten years, it would possibly answer his purpose to measure the discharge at several different stages and then from certain high-water marks, perhaps on some citizen's door-step, he could make a fairly good estimate of the high-water discharge without waiting ten years for the flood stage of the river.

The Engineers are accused of paying too much for materials and an instance is cited—without date, name or place, however—where the cost of construction per cubic yard, under the direction of the Engineer Corps was six times that of private enterprise. Of course I am unable to verify this statement, but I am confident that if the facts were all given, this charge would be found as groundless as the following: "The red tape system of the Army Corps requires that authority be obtained in advance for all expenditures, and consequently in cases of emergencies, losses fre-

quently occur for want of prompt action. A few years ago the Government plant at the mouth of the Saginaw River caught fire, and would have been destroyed but for the services rendered by a private tug, the vouchers for which were disallowed by the department for the reason that no authority had been obtained for the expenditure." In order to make this tale conform to strict verity it should be amended as follows: (1) The red-tape system referred to was created by law and the United States Treasury officials; (2) authority does *not* have to be obtained in advance for *all* expenditure; (3) emergencies are specially provided for; (4) therefore losses do *not* frequently occur for want of prompt action; (5) in this case the tug *was* hired promptly and paid for by General Poe, and (6) the vouchers were not disallowed by the Engineer Department, but by the Treasury Department, and *not* against the tug, as would appear, but against General Poe, and the lively protest of that officer caused a decided coolness on the part of the accounting officers of the Treasury. In short this bit of pleasantry, instead of being a good joke on the Corps of Engineers, simply shows one phase of the difficulties under which they labor.

It may be well to state right here that *any* Corps of Engineers whether civil or military, that may be organized by the Government, will necessarily be subject to law and regulations; and will therefore labor under the same disabilities and limitations as the present corps. This remark applies also "to the manner of awarding the contract for a light-house at Diamond Shoals reef," which Mr. Wisner tells us is—

"an example of professional cowardice, without parallel in the annals of American engineering. The Light-House Board, composed of men educated and supported by the Government for the purpose of designing and conducting such works completely, shift all responsibility in the matter and require the contractor to make his own survey and location, and make designs, furnish materials and construct and maintain the light for one year, before receiving any compensation, and besides this, give a heavy bond for the successful accomplishment of the enterprise. Why a bond guaranteeing success in an undertaking in which the Government has no responsibility should be required is a conundrum, that few outside of the Corps can answer."

In the first place the Light-House Board is not a part of the Corps of Engineers, but consists of civilians, Naval officers and engineers, in about equal numbers, and the Secretary of the Treasury is by law its President. Secondly, the question of bonds is a matter of law for which Congress is responsible. Thirdly, the

plan of inviting engineers and contractors to submit plans for such an important work has certain advantages and the successful contractor in this case so far as I can learn had no objections to that method nor to the treatment he received from the Light-House Board. I happen to know him intimately and have met him frequently during the preparation of his plans and since the unfortunate failure of the attempt to locate the caisson, and I have yet to hear a single word of complaint against any member of the Light-House Board, but he has spoken of them in the highest terms.

Mr. Wisner continues :

"There is another feature of the system of conducting business by the Corps which is even more discreditable than their failures. Officers interested in obtaining appropriations for certain harbors do not hesitate to advocate personally the measures before committees in Congress, and at the same time disparage other ports, often more advantageously situated for advancing the commercial interests involved."

Here we are again left without data, names or other clues to the delinquency. It is simply untrue that there is any such "feature of the system" as it is an inflexible rule that officers do not go before committees of Congress on such business unless sent for by the committee. If any particular officer has violated this rule, or if the complainant knows of an officer who is "interested in obtaining appropriations for certain harbors" in any way except a laudable professional interest, he should report the facts and the proof thereof at once to General Casey, the Chief of Engineers, who doubtless will not only be glad to get this information, but will take prompt and vigorous means to correct the evil-doer.

The statement that the duties of Engineer Officers under the present regime "amount to but little more than that of disbursing clerks," if true, carries with it the thought that all the engineering, which according to the same authority is "a disgrace to the nation and an outrage upon every practising engineer in the country," is the work of his brother assistant engineers. With the Prince of Denmark he can say :

"I have shot my arrow o'er the house, and hurt my brother."

Mr. Wisner does not hesitate to charge general dishonesty and incompetency upon Assistant Engineers and Inspectors, for he says : "If contractors could have honest and competent engineers in direct authority to deal with, there would be neither the opportunity nor the incentive on their part to do work such as of late

years has brought our public works into so much disrepute." Having had occasion to employ some thirty or forty Engineers and Inspectors on Government work, I feel justified in saying that this is a gratuitous libel on a most efficient and deserving body of men. My relations with them have been such that I am proud of having served with them and I have yet to see any indications that they felt humiliated or degraded by any treatment they received in the Government Service.

Mr. Wisner also imputes unworthy motives to Congress and to the engineering press of the country because they fail to join in his "hue and cry," saying "that this effort at reform has shown that the bad features of the system are to a great extent the source of its permanency," and that "it is also hinted that the managers of some technical journals, whose main support comes from civil engineers, and whose interests they should represent, do not give the matter the support they should, for fear of losing their columns of profitable Government advertising." Members of Congress, we are told, are afraid to advocate "reform" for fear the appropriations for their sections would be defeated. To this it may be replied that Congress has deliberately placed upon the Engineers the responsibility of recommending whether any proposed improvements are worthy to be undertaken by the Government, and although many of these reports are adverse to the projects, every year, they are almost invariably accepted as conclusive. Everybody knows that Congress can pass any bill they choose without consulting the Engineers at all and the Engineers would be only too glad to have them do so. The real cause of the apathy Mr. Wisner encounters in his efforts at "reform" is that the world has long since learned to distrust the man who wishes to "reform" himself into some other man's position.

Another charge against the Engineers is that "it is asserted hundreds of square miles of detail topography are filled in on the charts by guess and officially stamped as correct." Similar charges were made years ago against the Coast Survey with perhaps about the same basis. "They say," and "it is asserted," are very unreliable witnesses when brought into court. The surveys in question were made for special purposes, and it is quite possible that some of the topography beyond the region required to be mapped for use of the river improvement was put in hastily, and I am informed that much of the topography was done very rapidly and inexpensively. Mr. Wisner fails to specify just what parts of the surveys were worth-

less, and as he himself was engaged on these surveys, it leaves a painful doubt as to whether, having discredited the work and motives of almost every one else, he has begun to discredit his own work. He certainly owes the profession an explanation as to how he remained fifteen years in the humiliating and inefficient service without discovering the facts which he claims to have found out so soon after leaving the service. He had better adopt the motto of the late Mr. Billings—"Better not to know so much than to know so many things that are not so."

The "heaven-born" engineer comes this way only at long intervals and must feel lonesome. We must therefore take such engineers as we can get, remembering that perfection is not to be expected, though it should be aimed at.

The idea that there is something in the education of the Military Engineer that unfits him for the execution of Civil Engineering works is simply "rot," and arises from a dense ignorance of the facts. To show this let us in few words run over the process by which the Corps of Engineers is recruited :

First—Candidates are appointed from every Congress district in the country ; often by competitive examinations. This secures a *national* body of young men free from sectional, political or religious bias.

Second—These candidates are thoroughly examined, physically and mentally, and those who are deficient are rejected without fear or favor.

Third—Those admitted are subjected to eight other rigid examinations before they receive their diplomas ; and they are sometimes dropped out even at the last of these examinations.

Fourth—The studies embrace mathematics, drawing, physics (molar and molecular), geology, mineralogy, astronomy and civil and military engineering.

Fifth—The purely military studies occupy but a small portion of the time, and instead of dwarfing any of the other studies simply aid in developing the mind and furnishing applications for the other studies.

Sixth—The examinations have, at graduation, reduced the class to about one-half of its original size and sometimes less than one-third, and of those remaining less than one in ten are selected for the Corps of Engineering, or about one in twenty-five of those who enter are graduated as engineers.

Seventh—After leaving West Point the young engineer comes

to Willet's Point, where he usually spends three years more ; chiefly in practical work, such as topographic and hydrographic surveys, sounding and gaging streams, testing building materials, the use of steam and electrical appliances and high explosives.

Eighth—The theoretical part of this course includes such works as Harcourt, Schlicting and De Bauve, on river and harbor work, and examinations are held once a month during the winter term. Lectures have also been introduced, and the lecturers are civil as well as military engineers.

Ninth—The young officers then go out as assistants on the various engineering works, and are required to pass a rigid examination whenever they are promoted, which however occurs only at long intervals.

If there is anything in all this that in any way tends to get unworthy or improper persons in the Corps, or to disqualify them after they are in, I will be glad to have it pointed out. The system has produced such engineers as Turnbull, Totten, Meigs, Gillmore, Alexander, Warren, Weitzel, Merrill and others who have gone to their reward. Many have resigned and become civil and electrical engineers, and in almost every case they secure two or three times the salary that they received in the military service. In view of these facts I feel that the somewhat inelegant, though forcible, term I have applied to the twaddle about the military engineer being disqualified for properly executing the duties which Congress has confided to his care is fully justified.

Mr. Lincoln once remarked to one of the chronic growlers at military education : "I never thought West Point could put brains in a boy's head, nor that it will knock them out if they are there, when he enters."

Let us see what the reformer proposes to substitute for the Corps just described. How is the body of eminent engineers to be selected ? Have we any record of such a body of high-salaried officials being appointed without wire-pulling and unseemly scrambling ? Have we not found that even the Supreme Court is divided on strictly party lines on all political questions ? Is it likely that our eminent civil engineers, who generally find good salaries and plenty to do in private life, would sacrifice their independence and become Government employés under the much-ridiculed red-tape system, which, by the way, is nothing but method and system which are sometimes carried to excess ? Would the new system be independent of this and of the twin bugbears *esprit de corps* and

discipline, which is but another name for obedience to orders and respect for authority, that prevent a subordinate from criticising the work of his superiors?

It is not true that the military element predominates in the Mississippi River Commission, as four of the seven members are civilians, and questions are seldom if ever decided on military lines. President Harrison was for some time a member of the Commission, and, if the military members or the entire Commission were going wrong he has full power to correct it. The cut in the Red River dam was not an after-thought, as Mr. Wisner implies, but was ordered before the dam was raised to low-water mark. The Corps of Engineers is not responsible for the fact, if it be a fact, that the instructors of French and Spanish at West Point do not speak those languages. That institution is not a part of the Corps as it was prior to 1866. Neither is the Corps responsible for the "Grip," which now prevails to an apparently useless and inconvenient extent.

In looking over the foregoing I find that some things have been omitted while others, perhaps, ought to have been, but this article has been written within a very short limit of time, to meet the demands of the printer; and I know the reader will not grieve for what has been left out. As to the surplus, he must be lenient and bear in mind that "what's done we partly may compute, but know not what's resisted."

WHO IS AN ENGINEER?

By Oberlin Smith,

Past President Am. Soc. Mechanical Engineers.

THE time was, not so long ago, when the world recognized only three so-called learned professions. In the brilliant though incomplete civilization of this century, however, it is being admitted that the men who may to a great extent be considered its creators shall rank with the priest, the doctor and the lawyer as factors in the production of original thought, and in the carrying out in practical shape of ideas which have been given to the world by themselves and their predecessors. It is indeed a question whether to the engineer is not due much the greater part of the intellectual work which, after many preparatory centuries, has produced the wonderful developments of our modern life. Without his work, if left only to the ministrations of the other three learned professions, where would have been not only our railways and steamships, our telegraphs, telephones and electric-lights, our mowing-machines, sewing-machines and a thousand and one other labor-saving implements in agricultural and domestic life, the machinery of our factories of all kinds and the steam-engine itself, but even our buildings, roads, canals and bridges? In short, if it were not for the scientific thought and practical execution of work due to the engineer we should be living still in a state little above that of barbarism.

There is hardly space here to trace in detail the history of this noble profession. Its beginnings were evidently in the line of military engineering. In those times such men as were found to have sufficient brains were spurred forward by the "political bosses," otherwise called kings, perhaps under penalty of death or the loss of a pair of ears or some such slight incentive, to build forts and roads and bridges, as well as catapults and such other projectile-propelling machinery as the "state of the art" then permitted. From such conditions arose the military engineer. As time went on, the vital importance of his work developed a certain importance in the man, until his occupation became one of respectability, calling for a considerable degree of learning and research. When,

later on, the affairs of civil life became of considerable importance, the civil engineer naturally appeared more or less distinctly separated from his military brother. His is by no means an extremely young profession, however, as the wonderful roads and bridges of Rome, Greece and even Egypt testify unto this day. How far the occupation of the architect was distinct from that of the engineer in those early times we cannot tell exactly, but then, as now, the two vocations must have been intimately dependent upon one another, even in cases when not practised by the same individual. The popular impression that an architect is chiefly an artist, and an engineer only a scientist, is far from a correct one, as no great building can be made safe, durable, useful and beautiful without the scientific brain-work of the engineer, strongly tempered by an ardent love of the beautiful as well as an intimate knowledge of the accepted principles of color and of form.

Contemporary with these ancient military and civil engineers and architects must have been the miner and his brother the quarryman, although it is probable that the methods of mining were too crude and wasteful to have been governed by a distinct profession. The development of the professional mining engineer was by a gradual system of evolution, accelerated somewhat suddenly when the science of modern chemistry succeeded its parent, the superstition of alchemy.

Still later was developed what we now know as a mechanical engineer—so lately indeed that some of his useful and practical work seems even yet to lie without the pale of a learned profession. It is true that machinery has been built to some extent for thousands of years, as instanced by the engine of Hero, or the water-raising devices of the Nile. It is probable however that Hero's engine burned more than two pounds of coal per horse-power per hour; and we all know that the other old-time machinery was of such a crude description as to show that the best intellects of the time had not been occupied with mechanical work to such an extent as in architecture and in art. This latter work in Greece and Rome has been a model for all subsequent centuries, and its ruins are still a shining example to the modern world of the most refined intellectuality embodied in the most careful and conscientious labor, the products of which were destined to be a joy forever. Of the machinery of those times nothing of this kind can be said, and the principal aim of the modern designer is to steer as clear of old models as is possible—in details if not in general principles. We

deduce, therefore, that the profession of mechanical engineering is distinctly a modern one.

Still more modern is the latest, and perhaps by destiny the most important, child of embodied science, the electrical engineer. His works are only just beginning, but so rapidly and wonderfully do they grow that none of us can predict the end. He is so distinctly modern as to regard some of the work of his predecessor of four or five years ago as suitable only for a museum of antiquities. It is true that the foreshadowing of this profession commenced a good many years ago with such men as Galvani, Volta and Franklin, Faraday and Morse ; but it had not crystallized into the science of a great system of world's work any more than had mechanical engineering as foreshadowed by the great intellects of Leonardo da Vinci or the Marquis of Worcester.

Taking a practical view of engineering as it now exists, we find it in a somewhat chaotic state, not only in regard to its nomenclature but its practical classification. In a recent lecture before the Franklin Institute upon the "Possibilities of Applied Science," in attempting some natural division of my subject, I used the following words: "In trying to group under appropriate heads the sub-subjects we wish to examine together, an obvious method seemed to be to treat them as manifestions of science applied to the various arts by which man supplies his wants, and to take these somewhat in their natural order of importance in the development of civilization out of barbarism. The chief of such wants and desires are: Food, clothing, shelter, warmth, light, trade, travel, learning, art and health. This classification is convenient, rather than strictly logical, as some of the terms partly include some of the others. A more scientific framework for my discourse, but one which, for reasons to be mentioned, seemed likely to result in some confusion, would consist in a system of grouping by the sciences themselves, as: Agriculture, architecture, chemistry, engineering, etc. In trying to analyze the latter term, and fix upon appropriate adjectives for the numerous departments of modern engineering science, I was more than ever impressed with the inadequacy of our nomenclature in the matter of such definitions. In a comprehensive sense this science includes all the others, as applied to the useful arts, and, treating the subject with some degree of logic, we have engineering—agricultural, textile, topographical, hydraulic, mining, metallurgical, marine, vehicular, acoustic, aeronautical, chemical, educational, surgical, divisional, military, etc. The most

used adjective of all, "civil," does not appear in this list, because in its true sense it includes all the others except military engineering. So also the terms "mechanical" and "electrical" engineer are difficult to exactly define because, according to modern methods, their work enters largely into that of all the others mentioned, and includes the military field. Their functions are also somewhat interlocked with each other, so that they are all the time becoming more and more interdependent. From the somewhat awkward list given, which, by the way, is far from complete, it will be seen that the idea involved cannot be carried out without the coinage of new words. Upon the whole, it seems that the deeper one tries to look into the work of a systematic classification of applied science, the more befogged becomes one's vision. The truth of the matter is that we sorely need some congress of dictionary-makers—not only for the fixing with exactitude a meaning for many general scientific terms, but for the establishing of definitions that are definite, for thousands of words pertaining to the details of the technical arts."

However logical the profession may some time become in its own work, we must accept the fact that in this day a military engineer is, in many cases, of more importance to the world for his contributions to civil science and art than is he as a mere fort-maker, while the civil engineer, as known in this country at least, is becoming more and more limited, as a maker only of railroad-tracks, bridges, canals and certain types of buildings—not being able in many cases to complete his work without calling in the mechanical and electrical engineer, unless indeed he possesses a sufficiently great intellect to have himself mastered the details of these specialties. In Europe better verbal definitions exist, as it is usually understood there that the term "civil engineer" covers and includes all the branches of the profession, except those distinctly military. This of course gives a logical historical meaning to the words, and it is much to be deplored that we Americans have not followed our transatlantic brethren, instead of imposing the limitations which we have. A great and much needed reform, for the attainment of which we should all strive, and which can be brought about only by an extensive discussion of the matter followed by vigorous and organized effort, is to have one definite name for all of those practising professional engineering, and then to systematically and logically classify its special branches, both as now existing and as may be developed later. One among others of these divisions

would evidently be military engineering, and therefore it seems that the adjective "civil" would not be an appropriate prefix for the general name.

I shall not now attempt to point out the probable beginnings of such a classification as is undoubtedly destined to come, but before leaving the subject it occurs to me that one important question to be settled will be the relation of architects to engineers. To my mind it seems that they should undoubtedly be included with their less artistic brethren, especially in view of the fact that buildings are becoming more and more allied to other purely mechanical constructions and that their erection frequently embodies a vast amount of machinery for hoisting, ventilating, lighting, heating, power-furnishing, etc., even in some cases to the extent of half of their cost. If the argument is brought forward that art may suffer if the architect is allowed to become too purely mechanical, the reply is that the engineer must cultivate a love of the beautiful and the embodiment of this love in the construction of all things useful to an almost infinitely greater extent than he ever has done before in the history of the world; and we must all hope for the time soon to come when the ugly constructions which we now see in machinery, in electrical apparatus, in bridges, in industrial buildings, and in earthwork will be relegated to the past as a hideous nightmare.

All things considered, it would seem that the term "Engineer," standing simply and alone, would be the proper name for him who practices in the great and growing profession which dominates the civilization and progress of the world, whatever be his specialty; and that, furthermore, some simple adjective as a prefix should be authoritatively fixed upon for the designation of each of the specialtes included. Conflicting with this logical and simple scheme is the absurdity that in our American life the term "engineer," which with eminent fitness applies to men of the highest talent and education, engaged in the most intellectual of pursuits, is also freely applied to men who simply do the mechanical work of attending a steam-engine, men who in many cases know but little of its construction and would be utterly incapable of designing or building it, to say nothing of the higher grades of work beyond. In some cases such a man may be a mere laborer and unable even to read and write, if he happens to have sufficient native wit to keep a fire burning under a boiler and to see that no very great extraneous weight is loaded upon the safety-valve. It is therefore very much to be deplored that we have allowed the word "engineer" to

become popular in this sense, and the only way out of it would seem to be for our colleges, engineering societies and railway and steamboat companies to take hold of the matter jointly, to officially discountenance such confusing nomenclature. A vigorous official use of some such term as "engine-driver" or "engineman" by employers would perhaps gradually work the reform desired. In writing thus I have no wish to disparage such science as may be learned and applied by a bright-witted and ambitious young man who now dubs himself a "stationary engineer" and desires to become later a mechanical engineer. The members of the profession as a whole should extend a helping hand to every such rising young genius, but should, for his own benefit as well as theirs, insist upon his being known, at each stage of his development, simply *as what he is.*

In conclusion, we may perhaps well consider one of the most practical points at issue, viz., what authority is to decide the question asked in the title of this essay? Such authority cannot be the public at large; nor can it be the individual himself upon whom judgment is to be passed, who may perhaps be prematurely anxious to write an "E," accompanied by some other prefixed letters, at the end of his name. It has been suggested that some time our general government will have become prepared to take in hand such matters of national consequence as this—fixing the definitions and limitations of some of the more important professions, perhaps regulating the same through various universities that might be made competent to confer certain degrees upon individuals possessing certain different qualifications. Obviously the titles of engineers should be regulated as fully as in such professions as law and medicine, for the common purpose in all of preventing the danger incident to that quackery which threatens to damage and to rob clients seeking professional experts. All this does not mean that none but college-bred men should enter the ranks of engineering. It merely means that some system of examining boards properly constituted and controlled should pass upon the knowledge, practical as well as theoretical, of those who publish themselves as ready to give important technical advice, and to spend the money of their clients.

Until such time as there shall be some unification in regard to this matter, the best way to begin a reform in our own profession is probably through the great engineering societies, acting in conjunction with the important colleges, and strongly urging uniform-

ity in the matter of officially expressing their opinions regarding qualifications in candidates for practical professional life. In seeking analogies among other professions, it would appear that there is probably less quackery among the lawyers than among clergymen and physicians. This may be due to an especially thorough organization, in the way of Bar Associations, which help to maintain a desirable *esprit de corps* among their members. We all know how many lay-preachers and quack-doctors and medicine-makers there are to whom it is outrageous that we should even be allowed to trust our spiritual and corporeal welfare. These men should be compelled to attain to a certain standard of education and experience before being allowed to practice independently—as should lawyers and engineers.

If we glance over the actual status of the engineering organizations in the United States we shall find the four great national societies, the American Society of Civil Engineers, thirty-nine years old; the American Institute of Mining Engineers, twenty years old; the American Society of Mechanical Engineers, eleven years old; and the American Institute of Electrical Engineers, seven years old. Their total aggregate membership is about 5400, some 1200 of which are juniors, associates, etc. In addition to these we find the American Institute of Architects, the United States Naval Institute and several national railroad and electrical associations, besides over forty local engineering societies and railway clubs, some of which cover a section of territory embracing more than one city, and others of which are confined to particular cities with their suburbs. It is much to be regretted that for certain purposes of a general character, where the interests of the profession would be advanced by unity of action, there cannot be some national organization which could cover all the ground, or else some federation of the present societies, acting at certain times and for certain objects, for the benefit of all.

Some common organization is I think bound to come in the future, and this undoubtedly will become a nucleus of authority which will, in the estimation of the public, develop into a tribunal capable of deciding the questions here discussed.

CIVIL ENGINEERING.

THE Direction of Impact of High Explosives, has recently elicited a rather interesting discussion. Mr. George H. Benjamin, who, as an expert, testified at the coroner's inquest on the recent murderous explosion in the office of Mr. Russell Sage in New York, is reported in the New York *World* as saying that the explosive used by the assassin "was not giant powder, nor black powder, nor gun-cotton nor nitro-glycerine. Each one of these explosives would have acted downward, instead of upward and sideways. Had it been dynamite a great hole would have been blown in the floor and poor young Norton would not have been blown out of the window." This statement has been challenged by a correspondent of *Engineering News*, who says, with reference to the general belief that the impact of nitro-glycerine and its compounds is always downward, that his "experience has been that it is exerted in exactly the opposite direction from that in which the primal force is applied; for instance, a cartridge charged with cap on top of explosive, and with fuse pointing north, the greatest force of the explosion will be in a direct line south." He adds that he believes that "while the tendency of all glycerine explosions, in the vicinity of the explosive, is to rend, tear, or, in other words, totally annihilate any and all substances, yet the true explosive force which we wish to confine, direct or use will be found to follow a straight course, almost as if the same were confined within the diameter of a large tube until its force is expended." Whereupon *Engineering News* takes up the discussion and dissents from both the view of Mr. Benjamin and its correspondent. In the opinion of the editor of that very able and excellent journal the law of the expansion of gases should account for all the phenomena attending a nitro-glycerine explosion, or of any of the compounds of nitro-glycerine. As is well known a compressed gas expands, when left perfectly free to expand, equally in all directions; and this our contemporary thinks is a sufficient reason for a denial that the gas generated by a nitro-glycerine explosion exerts an expansive force any greater in one direction than another. It must be confessed, that under the assumption that all the force of such an explosion is due to the expansion of the gas suddenly generated by the decomposition of the explosive, this view is unassailable. There are, however, those who, like the writer of this paragraph, deem it at least possible, that there is something yet to be learned about the force generated in explosions of nitro-glycerine and dynamite, and it may be found that electricity plays a part in it. Whether the latter, or any one of the four different views relative to this explosive action be correct their simultaneous existence is significant of the fact that its exact nature may be further and profitably studied. As to the direction of Impact, *Engineering News* thinks it would be on the line of least resistance; but, as impact implies a resistance, it would appear that this proposition is not adequately stated. We suggest that it would be more explicit to say that the direction of maximum impact is in the line of least resistance but toward and upon the point of greatest resistance. In our department of "Comment and Criticism" any additional confirmatory or dissenting expression of opinion upon this interesting topic will be welcomed.

The Ventilation of Tunnels is, according to an opinion of a writer in the *Railroad Gazette*, who signs himself "*M. Am. Soc. C. E.*," shirked, simply on account of its cost and not because of any actual impracticability in carrying it out. That able journal is credited by him as being singular in its estimate of the importance of the subject, and he charges that "other engineering journals accept without question the unwarranted assumption that ventilation will take care of itself." He also

charges that "the subject has been glossed over by promotion engineers who know, or ought to know better." As proof that such ventilation is entirely within present engineering resources he cites the ventilation of the tunnel under the Mersey at Liverpool, Eng. This tunnel is reached at one end by an elevator of 70 feet lift, and at the other by one of 90 feet lift, and is of sufficient area of cross section to prevent entirely the piston-action of trains upon which so many confidently rely, or pretend to rely, as an infallible remedy for foul air in tunnels, "its cross-section being several times that of the trains." Nevertheless, it is thoroughly ventilated, the means whereby this is accomplished being a "smaller side drift or tunnel running alongside of the main tunnel to the shore end, where is fixed a large fan." The side drift is connected with the middle of the main tunnel by openings. This secures the complete removal of all the air in the main tunnel within a specific time, but as pointed out in the article quoted the ventilation both of the tunnel proper and cars is rendered more perfect by the system employed. "A train starting in pure air at the station follows the air travelling in the tunnel up to the center. Any change of air between train and tunnel is thus less than it would be if the air in the tunnel were not moving. Past the tunnel center the train begins to travel against the moving air. By that time the air in the train will be more or less fouled by the passengers and the ventilation due to train motion then begins to increase. The first air entering from the tunnel to the train is perhaps as good at that time as the air in the train. As the train proceeds it meets purer air at every foot forward, and when it reaches the station its air is of surface quality again. To whatever extent the ventilating fan is short of the power to rid the tunnel of smoke before another train comes along, the fault is minimized by the system."

The Accident at Hastings, N. Y., on the Hudson River Division of the N. Y. C. & H. R. R. has brought to light some interesting facts relative to block systems on United States railroads. Among these is a statement made in the New York *Herald*, that General Superintendent Voorhees has for several years been striving to have the managers of the road adopt some efficient block system. Upon this statement the *Railroad Gazette* makes the pithy comment, that whether Superintendent Voorhees, ever uttered the language attributed to him by the *Herald* reporter or not, "*it very likely tells the truth, whatever he may have said.*" The *Railroad Gazette*, which has a commendable habit of saying wholesome truths in a plain fearless way, adds:

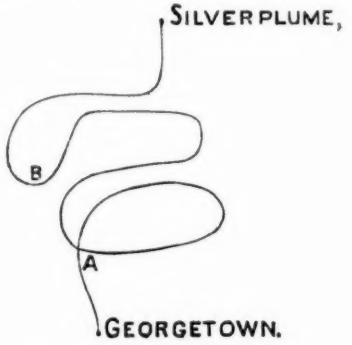
"This illustrates a phase of the Superintendent's life that is very familiar on a great many roads. The officer who has the direct management of those details which involve life and death has a continual contest with the ideas of the men who are more immediately interested in the dividends for *this year*. The great majority of railroad directors are men who, like Jay Gould, 'look above and beyond details, to the earning capacity'; but they are subject to the limitations of humanity and do not make sufficient effort to look above and beyond the present. The most independent railroad manager of our acquaintance was one who had paid no dividends for 14 years and who said that he had got his stockholders sufficiently subdued so that they would not demand any for 14 years more. He paid his interest and the road did not fail; he simply put all the profits into the road. * * * The Superintendent of another New York road said, confidentially, the other day, that he had begged and even implored for an appropriation for the block system on his road. He had not got the money, the last we knew, but we have heard of one road that suddenly ordered some block signals the next day after the Hastings Collision."

However, it appears from the same source, that a contract had been made with the Johnson Railroad Signal Co. only a few hours prior to the accident for placing a block system between Peekskill drawbridge and Poughkeepsie, which, when completed, will make a continuous system over a distance of 73 miles from the New York Central depot, and will in the opinion of our esteemed contemporary make this "one of the most perfectly equipped pieces of road in the country." It has since been announced that contracts have been completed for block signals to Albany.

Still Another Mode of Ventilating Tunnels, is described in *Industries* (London), as having been successfully tested on a portion of the main line of the Metropolitan railway between Neasden and Harrow. "A rectangular flue, having at intervals valves opening downward on its top side, is placed between the rails, one end being closed and the other end being connected with a blower." Thus the air in this flue being continually exhausted, an inrush of air from the tunnel into the exhausted flue through the downwardly opening valves takes place when the valves are opened. These are successively opened during the passage of a train, by a rib on a long sliding box under the locomotive, this box being in reality a smoke flue connected with the bottom of the locomotive smoke-stack. Now, the smoke-stack is provided with two valves under control of the locomotive driver. As the train enters the tunnel one of these is closed to prevent smoke from issuing at the top of the stack, while the other is simultaneously opened to allow the smoke to enter the long box under the locomotive. This box, by the continuous opening of the valves in the ventilating flue between the tracks, being constantly kept in communication with the interior of the flue, the smoke is discharged directly into the flue and from thence drawn out by the blower into the outer air. We are not, however, prepared to accept the statement of the results of the test of this apparatus as final or very encouraging. There are too many things to be looked after and kept in order to render such a system practicable. The system described in the preceding paragraph for the tunnel under the Mersey has not this great fault, and the two systems form an interesting contrast between severe mechanical simplicity and extreme complexity.

As Relates to Automatic Car-Couplers the figures in this paragraph are taken from a statement made at a meeting of the National Convention of Railroad Commissioners held in New York, on November 10, in the rooms of the Chamber of Commerce, by Chairman Crocker. This gentleman stated that replies had been received from companies owning and controlling 125,000 miles of the railroads of the United States, and that from these replies it is gathered that only 129,304 freight cars out of 978,161 in use on these roads have automatic couplers. Of these 118,928 have the master car builders' couplers (vertical hook couplers) leaving only 13,279 fitted with other styles of automatic couplers. These cars are for the most part fitted with hand-brakes, only 110,127 having train brakes, the latter being nearly all Westinghouse brakes.

The Famous Loop at Georgetown, 50 miles from Denver, is described by Mr. D. J. Flynn, in *New York Railroad Men* with a diagram herewith reproduced. Mr. Flynn says:



"The loop proper is the connecting link between the two mining camps of Georgetown and Silver Plume, the latter point being about a mile and a quarter from the former as the crow flies, but about 700 feet above it. The line of the road from Georgetown to the Plume is about four and a half miles in length. This road is through a very narrow gulch, high mountains forming either side, and the railroad utilizes the sides of the opposite mountains in making the ascent. The grade is four per cent. (211 feet to the mile—almost the highest practicable grade in operation), and at the point marked 'A' the track crosses itself on a bridge 96 feet above the lower course, thus forming the 'loop.' 'B' represents a high fill where the train is turned to run into the Plume, and from this point four levels of track are in full view. It is a marvel of engineering skill."

The Disposal of Sewage, is an ever live question, and as the health of towns and

cities is intimately connected with it, anything new pertaining to it claims attention. Failures are often no less instructive than successes. A new system of cleaning out sewers now on trial in London appears to us to have such merit, as, probably, to be destined to take its place in the line of permanent advance in sanitary engineering. Heretofore, when sewers have become clogged, it has been necessary to remove manholes, and dip out the fetid accumulations with buckets, the air being thus contaminated sometimes whole blocks away from the open holes. The system referred to, which has been described in a recent number of *Invention* (London), cleans sewers without the necessity of opening them. A device called a "*flusher*" is used. This consists of an iron pipe closed at one end but having at the closed end a number of radially arranged copper jet pipes. The open end is fitted for a hose-connection. This pipe is mounted on wheels and has a rope attached whereby it may be hauled through a sewer to be flushed, while a portable pumping engine supplies it with water through a hose. One sewerman draws the flusher along by means of a rope, while another reels out the hose. A third man connects additional lengths of hose as needed. A fourth man attends to the pumping engine, which sends the water through the jets under a pressure of 70 pounds per square inch. It is stated that by this apparatus the entire interior of the sewer is successfully washed and cleansed, and that in two hours the four men can do as much sewer cleaning as can be done by the old method in two days.

The First Railway in Sumatra, will soon be completed and fully opened for traffic. A part has already been used. It has been built by the Dutch Government. The line will connect the coal mines of Lounto with Port Emma, the latter being the principal Dutch port on the Island. A branch, 12 miles in length, connects Fort de Kock with the main line. The total length of the line is 98 miles exclusive of the 12 mile spur; but the air-line distance is very much less. The circuitous character of the line has been necessitated by the mountainous nature of the country traversed, and in all 18 miles of rack-rail has been needed to surmount several of the greater acclivities. Both rails and sleepers are of steel; for, although plenty of timber is found along the line, the rapid decay of wood in that climate has discouraged its use for sleepers. The iron work of the cars has been manufactured in Europe, but the wood-work will be made on the island, of a native timber suitable for the purpose. Native Sumatran and Chinese labor has been principally employed in constructing the road, including the necessary tunneling and the culvert and bridge-building which are prominent features of the road, owing to the uneven character of the country and its numerous streams. A good deal of the work was done by native convicts. A telegraph line extends the entire length of the road. At first the natives had a superstitious fear of the locomotives, but this has almost entirely disappeared. The freight traffic of the road will be chiefly the transportation of coal to the seaboard, but it will also have a large business in the handling of coffee, rice and tobacco. It is said that a considerable native passenger traffic has already grown up, with every prospect of a rapid increase. At Port Emma good facilities for handling the coal and transferring it to vessels have been supplied.

Advice to Young Hydraulic Engineers is contained in an article recently contributed to the Troy *Polytechnic*, by Mr. Wyncoop Kiersted, of Kansas. Thorough technical training at some accredited institution should, he thinks, be followed by apprenticeship with some hydraulic engineer of established reputation. The young engineer at this period ought not to aspire to the position of an assistant. After his term of apprenticeship is past, he may venture upon original design, and take a more responsible position. His term of apprenticeship may be longer or shorter according to the character and previous training of the aspirant, but, whatever its length, constant reading of books and technical journals, together with copious notes of everything pertaining to his profession that comes under his observation should be kept up.

ARCHITECTURE.

AS Related to Ventilation, especially as ordinarily carried out in domestic heating apparatus, the rate with which various vapors and gases diffuse into each other demand further study. Exact experiment can only solve this question. By *rate* of diffusion is meant the velocity with which one gas or vapor traverses another. The coarse experiment of the diffusion of smoke in air which some have thought to be typical of the diffusion of gases, is wholly untrustworthy as a guide to any correct conclusion in this matter. For smoke, even of the most attenuated sort, is neither a gas nor a vapor, and has no physical analogy to a gas. What we call smoke may be mingled with invisible gaseous products of combustion, but the part that is visible, and that can be watched in its progress through the air of a room, is minutely divided solid matter, a dust, so to speak, of carbon, and its movements indicate only the corresponding movements of the air, as a mass, in which it floats. The diffusion of gases, on the contrary, is not a movement of their mass, but a mutual separation of their particles or molecules, and the commingling of these molecules in accordance with a definite law of pressure and volume. The process, in its very nature, must be invisible; for, as yet no mortal eye has ever seen a molecule, and probably the effort to do so by any refinement of method, or by the use of any optical magnifier, must be as hopeless as an attempt to see a differential of an area, as the latter is defined in mathematics. Some preliminary, crude, and tentative experiments have been made by the writer, which seem to show that rates of diffusion vary with different gases. In a recent article on Ventilating Homes and Schools, published in this magazine, it is stated that carbonic acid gas is a harmless indicator of harmful gaseous impurities which always accompany it as generated by respiration. If, however, the rate with which the harmful impurities progress through the air in an apartment be either greater or less than that with which carbonic acid diffuses, it follows that the rapidity with which the air must be changed to effect good ventilation cannot be determined by the presence of carbonic acid in some given part of a room in excess of that in another part. An excess of carbonic acid may be found in a stratum next or near to the floor, while the harmful impurities may have much more rapidly diffused and thus become more uniformly distributed throughout the space. Let no one think that diffusion is an instantaneous process. Diffusion of liquids is an entirely analogous action to that of gases, and the latter, as any one may see, varies in rate according to the nature of the liquids themselves, the property of viscosity being probably the chief factor of delay. Air and all other gases have also the property of viscosity, in varying degrees, however, the same as liquids. As the mechanical agitation of liquids hastens their commingling, so the mechanical agitation of gases accelerates their diffusion. The very act of introducing pure air, by its mechanical effect upon the air in an inclosed space, must assist diffusion. Moreover, mechanical agitation accelerates diffusion more in some liquids than in others, and undoubtedly the same thing may be asserted of gases. Whoever will perform careful and scientific experiments upon this subject and publish the results, will furnish data for the solution of many anomalies in ventilation that have hitherto only been explained by some ingenious hypothesis.

Further Criticisms of Tall Buildings, are coming from authoritative and influential sources. One of the indications that the craze for these buildings cannot long be

maintained is contained in a very sensible and moderate editorial printed in the *Northwestern Architect* for November. Commenting upon the remarks of President Hunt, at a recent convention of the American Institute of Architects, the author of the article referred to says, that private conversation has confirmed the belief that President Hunt's views are very generally concurred in by a large number of the most prominent architects in this country; and this, while "outside of the profession the discussion is beginning to assume the phase of 'the greatest good to the greatest number'—the thinking part of the public to a considerable extent having recovered from the benumbing effect of *mere bigness*. People are now asking about their rights to light and air; and many are beginning to realize that their lofty neighbors are depriving them of rights of great value." The article goes on to criticise the fashion of these buildings, not merely on account of the total lack of artistic features that most of them display, but because, "in their relations to their neighbors, they are too grasping, too assertive for well-mannered and popular individuals of the community of buildings. Had the modern high building claimed less, its supremacy might have stood longer unchallenged." This is admirably put, but greater stress might have been laid upon the unsightliness of the large majority of these buildings wherever erected. To an eye accustomed to the appreciation of architectural beauty, nine out of ten of them are simply hideous. Only in rare cases—notably the Times building in New York City—has anything like a pleasing style been achieved and this example is not merely an exception; in the writer's opinion it is the handsomest tall building yet erected in this country.

An Interesting Method of Ventilation for the great hall of the new Sorbonne, in Paris, has been designed by M. Nenot. From the *Sanitary News* we condense the following description of this apparatus: In a mixing chamber comprising the entire space under the auditorium, hot and cold air are mixed to the exact temperature desired. This air is forced into the auditorium through a great number of small holes, covered with wire netting, not only the floor but the fronts of the seats being utilized for this purpose. A special conduit also delivers air to a space behind a molding near the floor and close to the wall. The method pursued in ventilating the hall is as follows: Before the entrance of an audience the walls are thoroughly warmed by forcing air heated to 200° F into the conduit described. The wall is thus heated to a temperature of 100°, or thereabouts, a temperature that by radiation will keep the audience comfortable while ventilating the hall with air at 60°, and will also cause *ascending* currents to move constantly over the interior surfaces, thus preventing the downward cold drafts always present near walls colder than the air inclosed by them. The system of ventilation is upward, the vitiated air passing through openings in the ceiling. The main principle in this system—that of maintaining the walls at a higher temperature than the air they inclose—is not new, except in the ingenious method whereby it is accomplished, which is easily applied.

An Ingenious Instrument for detecting Movements in Masonry, has been devised by Mr. E. P. Abbott, Chief Engineer of the Minneapolis & St. Louis Railway. He used the instrument for measuring the movement in a cracked abutment of the Second Street Bridge in Minneapolis. As the instrument is applicable to the testing of any kind of cracked masonry a description of it will be interesting to architects as well as engineers. *Engineering News*, in its issue of December 19, gave an illustrated description of the instrument and its application, from which we condense the following account: To the masonry, on one side of an incipient crack, is attached in a fixed position the works of an ordinary Waterbury watch. Horizontally, and at a short distance above the watch is a light metal rod supported between two brackets respectively placed one on each side of the crack. This rod has one end adjustably supported by the bracket that is separated from the watch by the intervening crack. The other end is supported by

a short rock-lever fitted upon the hour-hand post of the watch movement. A light, coiled spring is also connected with this lever, and is fastened by a staple inserted in the masonry, the crack intervening between the staple and the watch. On the spindle of the hand or pointer of the dial is wound a thread of silk, to the dependent end of which is attached a weight. That bracket which is attached to the wall on the same side of the crack as the watch movement, performs the function of a stop or abutment for the end of the rod that projects beyond the lever fitted to the hour-hand post. The weight suspended from the pointer-spindle takes up all the slack in the movement mechanism, while the spiral spring takes up all the slack in the connection of the rod with the lever. This arrangement is so delicate in its action, that the widening of the crack a distance of one-sixteenth of an inch will cause more than a complete revolution of the pointer on the dial. In adjusting the instrument the rod is made, by a nut, to abut exactly against the stop on the bracket on that side of the crack where the watch is fixed. The brackets are parts, or may be made parts of an electric circuit of which, also, the rod is a part, so that any movement of the rod separating its free end from the bracket near the watch, may be electrically indicated while the pointer on the watch-dial gives a micrometric measurement of the increase in the opening. The instrument proved that no widening of the crack occurred during an interval of three weeks. Finally, the cost of this extremely ingenious mechanism is stated by Mr. Abbott to have not exceeded $6.

As to Wire Lath, the statements of Mr. John McGlensey, Chairman of the Employing Plasterers Association, recently made to the New York Committee on the revision of the building laws, appear to have been highly commended. They expressed the views of a thoroughly practical man, of wide experience, keen powers of observation and much more than ordinary intelligence. One recommendation made by him, that all plastering should extend down to the floor behind, instead of stopping off at baseboards, as has been common custom in the cheaper class of city buildings, appeals at once to the good sense of any one who thinks about it. As an element of slow burning in case of fire, as an obstruction to the passage of vermin into interior wall spaces, and as rendering the heating of buildings much easier, this system ought always to be strictly required. This efficiency of wire lath, as a fire-resisting material, needs only to be thought of to receive immediate assent. A wire netting, while affording a good "key" to plaster, baffles mice and rats that will often make their way through ordinary wooden lath and plastering. Its power of expansion under heat without injury to the plastering held up by it exceeds that of every other form of metal support for plastering, and it may be easily and securely fastened to studs. As evidence that the views of Mr. McGlensey produced a profound impression, we may add that the committee requested him to write them out and resubmit them.

The Eiffel Tower is stated upon what *Machinery* (London) calls "the best and most reliable authority" (which, however, it does not name more specifically) to be in a dangerous condition. It is claimed that a slow, but sure, process of destruction is inevitable for this famous structure, and that a panicky feeling exists among the residents of the *Champ de Mars*, who are sufficiently near the structure to incur risk of injury from its fall should such an accident ensue. This feeling has been engendered by the assertion, said to be made by a competent engineer, that the supports are gradually sinking. Some accompanying statements printed in connection with the above, excite a suspicion that the structure has been calumniated; yet the failure of the Moenchenstein bridge, and its causes as set forth in the report of Profs. W. Bitter and L. Tetmajer, the Swiss experts who made an investigation of the structure, do not afford much assurance that the tower is free from structural defects. It will be remembered that the bridge alluded to was built from designs of Messrs. Eiffel and Lavallois. Its failure is attributed by the experts above-

named to fatal deficiences in strength, and flimsy construction in many of its details. Should the Eiffel Tower also collapse, the fame of its constructor which, rocket-like, suddenly commanded the attention of the world, will come down like the stick of the familiar adage.

The Leaning Tower at Saragossa, in Aragon, is reported to have reached a stage of decrepitude that will demand its taking down. This structure is a famous clock-tower of extraordinary architectural beauty, and it is really to be regretted that its removal is thus compelled. Its immediate dangerous condition has resulted not from any defect in its architectural design, but from the subsidence of its foundations caused by rains and floods. Its leaning position is attributed to carelessness on the part of the builders. *Architecture and Building* gives the following account of this noted structure:

"The construction of this torre inclinada was begun in the fifteenth century, under the direction of two Spanish, two Moorish and one Jewish architects. It is octagonal in form, 300 feet high, 45 in diameter, and leans about 10 feet out of the perpendicular. Stone steps, 260 in number, lead inside to the top gallery, whence a magnificent and beautiful view is obtained over the city itself, the fertile plains of Aragon watered by the rapid-flowing Ebro, and away to the north where the Pyrenees are seen. The edifice, built of bricks, has at a distance a Moorish aspect, the face of the structure being diapered with brick-work, but the design and execution are much coarser than are generally seen in purely Moorish buildings; the various windows, galleries, battlements and turrets, together with designs partly Byzantine, partly Arabesque, demonstrate its mixed architecture."

As to the Cleaning of Paint and Varnish, subjects which architects have frequently to consider in the course of repairs and the re-decoration of buildings, Messrs. C. B. Budley, chemist and F. N. Pease, assistant chemist, of the Pennsylvania Railroad, state in one of their contributions to the *Railroad and Engineering Journal* that the whole subject needs more study. The detergent used by the Pennsylvania Railroad as the best yet fixed upon by the experiments of the gentlemen named, is a mixture of powdered soap and tripoli in proportions of about three parts of soap to seven parts of the pumice stone, and it is applied with friction by a wet or a damp cloth. The slight solvent action of the varnish due to the soap, and the mechanical action of the pulverized pumice-stone or tripoli result in the cleaning of a very dirty surface with very little injury to the gloss of the varnish, provided the tripoli or pumice-stone is sufficiently fine.

A Magnificent Hotel, which, it is claimed, will be, when completed, the finest yet erected on the American Continent, is projected for the City of Mexico. Its cost will exceed $2,000,000. Of this sum, half will be furnished by the Mexican Government, and the balance is to be supplied by a Mexican Syndicate. A further concession has been made by the government, in permitting the importation duty free, of all materials needed for the construction. The stone for the building will be quarried at a distance of 70 miles from the city. There are to be 400 rooms for guests, together with all the most approved modern hotel appliances, the whole to be decorated in the most tasteful and expensive manner. The designs for the rotunda, and the Turkish baths are specially mentioned as being superb.

A New Electric Letter-Delivery System for the better class of flat buildings is described in our electrical exchanges. The system provides for distributing letters or parcels to different flats in large buildings. A letter-box in the basement has compartments corresponding to the various flats in the buildings. The act of placing letters in the box establishes an electrical communication with the top of the building, releasing a stream of water from a tank which fills a cylinder connected with a box after the manner of a counterpoise weight in an elevator and draws the box up through the building, an automatic contrivance being provided for the discharge of the letters from each compartment at its proper floor. The cylinder, having thus drawn up the box, automatically empties itself of water, when the box again descends ready for further deposits.

ELECTRICITY.

THE Experience of an Electrical Engineer's Apprentice is narrated in the *Electrical Review* (London), for November 13th. This experience resulted in a suit for an alleged breach of the articles of apprenticeship on the part of the defendant, to whom a widow had apprenticed her son, the son testifying that he had not at any time been properly taught or instructed in the art or business of an electrical engineer. It appeared also that the defendant had at one time refused to allow the young man to attend at the work-shops or places of business of the defendant for a whole month, and that subsequently the defendant had discharged the lad. This young man had been kept for nine months filing and fitting brass rods and running screw-cutting machines without the slightest instruction in electrical engineering. The court held that the defendant was not justified in keeping an apprentice for that length of time at the mechanical work described. The whole business of directing the lad had been relegated to the manager, and from him to the foreman, and the foreman had used the lad as a person employed only to do mechanical work. The defendant was ordered to pay costs of action and damages amounting to £120. The *Electrical Review* mentions instances of other lads who have been similarly treated and rejoices that the example made of the defendant in the case described is likely to have a salutary effect upon the future of other electrical apprentices.

A Charge that the Electric Light is injurious to eyesight has been recently made in the London *Morning Post*, which stated that unless shades are used to soften this light, it is most injurious and in cases of weak sight absolutely pernicious. The *Electrician* for November 27th makes this assertion a text, and alleges that it is not "too strong if it is taken as relating to the senseless way in which electric lights are too often placed." It cautions the *Morning Post* however in the language of the old story of the judge advising a junior, "Give your opinion, it will probably be right; reserve your reasons, they are sure to be wrong." The writer in the *Morning Post* seems to think that there is something essentially injurious in the electric light, and that this may be cured by the use of tinted shades. The *Electrician* commenting still further upon the article states that the discomfort from the electric light is caused by the fact that "the filaments are visible and dazzle." Two ways to meet this difficulty are used, one of which is to place the lights high enough, so that the eye is rarely directed toward them; the other to screen them in such manner that the eyes cannot see the filaments. The opaque reflectors, or screens for lights set low down, are essential. The real defect in electric lights, that still exists in some instances, is its irregularity especially that with lamps driven by small gas engines. The *Electrician* asserts that "a very slight variation, almost, or perhaps quite imperceptible when looked for, may prove very tiring after an hour or two." And it thinks that some physical measurements ought to be made to determine whether the light supplied by leading companies is perfectly steady or not. The question whether such an investigation would be worth while, is answered by the argument that it would probably "silence the grumblers."

The Function of the Air-Blast on the Thomson-Houston, three-coil dynamo, according to Mr. J. Stanford Brown, has been the subject of a wide-spread misconception. In a communication to the *Electrician* (London) he calls attention to this error, and explains the true function of this well-known device, by quoting therein Prof. Elihu Thomson (the inventor) as saying that the common expression "*blowing out the spark*," as applied to the action

of the blast, conveys "an erroneous idea." In Silvanus P. Thompson's treatise on "*Dynamo Electric Machinery*," the statement is made that the blast is for "*blowing out the spark*," and this, perhaps, is some excuse for the error on the part of those less learned in electrical science. Prof. Elihu Thomson says this "is not and never was the function of the air-blast, its true function being "to make it possible to run the machine steadily at high differences of potential with a commutator which could be freely oiled." He states that in the early construction of a machine of any capacity above from 12 to 15 lamps, a tendency to short circuit or flash over at the commutators was developed, this tendency, of course, becoming more marked with each increase in the difference of potential. "It was also desirable to run the commutator with a film of oil to freely oil the machine; and when the commutator was freely oiled the limiting potential which could exist without flashing over was much lower." The remainder is better told in Prof. Thomson's own language:

"In the early days men would oil the commutator. It was almost impossible to keep them from taking an oil-can and squirting on the commutator. The reasoning used in getting the air-blast was this, that on the leaving of this segment there would be a small amount of current still fed from the segment to the brush, which would, as it were, tail off, and the sparks would be thicker at the brush and gradually thin out to a fine point and then stop. Then the segment would change polarity and go on to the other side. But, naturally, if the change of polarity was immediate on the cessation of that spark there might remain, as it were, from the spark, hot gas, which would enable the discharge to take place in the opposite direction, and that was a flash which would be carried over from the arc. My idea was simply to blow a cold blast of air, as it were, to drive that spark away and insert, no matter how thin, a layer of cold air before the reversal was accomplished, and in that way *to keep the insulation* of the machine."

An Electric Power-Hammer is described in our English exchanges. It has some interesting features. The main principle of the hammer is that of a reciprocating core in a helix, or more properly helices, as will be further explained. The general appearance of the hammer is strikingly (no pun intended) like that of a steam-hammer, only, in this case, the cylinder, or what corresponds to the steam-cylinder of a steam-hammer, is a series of enormously powerful coils, a reciprocating core connected with the hammer-head taking the place of a piston. In lifting the hammer for a blow the current is successively passed through the coils from the bottom upward, and the soft iron piston thus becoming magnetic is attracted upward into and through each helix, the circuit through each coil being opened as the piston passes into the next, till the piston is fully raised. Then the circuit being broken in the top coil, a current is passed through the next one below it and so on successively in each of the coils downward. The piston and attached hammer-head are thus projected downward, not merely by the action of gravity, but by electro-magnetic energy, and a powerful blow is delivered. The passage of the current through the coils may be regulated to raise the hammer-head to any desired height, and to check its descent, so that blows of varying force are within the capacity of the machine, as in the steam hammer. It is said that in a casual observation the only perceptible difference between this electric hammer and a steam hammer is the absence of the steam and exhaust pipes.

The Yokohama Electric Light Company in Japan is stated to be in a condition of serious financial embarrassment. From the report of a committee appointed to make an investigation of the company's affairs, the English papers state, that, of the total subscribed capital of £300,000 only £84,371 has been paid up. The monthly expenditures are £420, while the average monthly receipts are only about £200. The loss is therefore at the rate of $1000 a month in U. S. currency, and the indebtedness of the company at the time of the investigation was £10,000. The parties in interest are much discouraged, as there appears very good reason for their being, and the progress of electric lighting in Japan has received a severe setback.

Removing Superfluous Hair by Electricity is the title of a paper read by Dr. Plym S. Hayes before a meeting of the American Electro-Therapeutical Association. With reference to the efficiency and practicability of the use of electricity for this purpose. Dr. Hayes stated that the chief difficulty in its application, either for therapeutic or cosmetic purposes is the liability to leave indelible scars. He recommends the use of a blunt-pointed needle instead of a sharp one in order to reach the bottom of the hair follicles without doing violence to the tissues. However, he regards more or less injury to the tissues to be an invariable attendant of the method, the use of the blunt needles and the careful manipulation recommended by him being for the purpose of reducing this difficulty to its lowest terms. He has found much difficulty in obtaining needles of the proper diameter which he names as from 1-200 to 3-200 of an inch. These needles, he thinks, from the operating extremity to a distance of 1-16th of an inch, should be slightly thicker than the shaft, the points being as nearly as possible a hemisphere. The danger of using a conical point is that the walls of the hair follicles are likely to be pierced. The best results are accomplished with the thinnest needles. A current strength of from three-fourths of a milliampere to a milliampere and a half—in rare instances possibly three milliamperes—is regarded by him as proper. In inserting the needle it should be made to follow the hair as accurately as possible. However, with the most approved apparatus he regards success as dependent as much or more on the man as the means employed; and he closes his paper with the statement that "every operator leaves his record on the face of his subjects, and success or failure, as well as gratitude or regret (according to the result), is accorded to him who essays this simple yet delicate operation."

The Electric Light in the London Clubhouses has been a boon to cockroaches, if we may credit a statement made in *Invention* (London). That journal states, that in one of the principal club houses in the English metropolis "the cockroach nuisance has enormously increased in the kitchens and other hot places, since the wires for electric lights were carried across the kitchens." The cockroaches, it appears, find the grooves wherein the wires are laid, just exactly the home which suits them. Therein they are safe from any of the ordinary or extraordinary means of warfare by which they are usually compelled to retire from their intrenchments. There they live in security, bring up and educate their numerous families, and when nocturnal shades favor excursions, they sally forth like the locusts of Egypt, to the great disgust and discomfort of the clubmen. To remedy the evil, it has been found necessary to remove the wooden casings wherever carried over stoves, or in any other warm place, and substitute for them lead or composition tubes supported on brackets to clear the ceiling, and having their ends well stopped with some plastic composition.

The Ferranti High-Tension Scheme, installed at Deptford, Eng., is, even with some of those who have most warmly supported it, beginning to be deemed impracticable. It is found that the maintenance of the insulation at the enormous pressure of 10,000 volts is a matter of great difficulty, and already there are hints of some projected modifications of the scheme. The *Electrical Review* (London) has always regarded M. Ferranti's scheme as impracticable, and now styles M. Ferranti a *clever enthusiast*. It says "the Corporation is in many respects in a good position to do excellent work; but this can only be fully taken advantage of by materially modifying the existing state of things. Probably this must involve a heavy outlay, but such an expenditure can hardly be called throwing good money after bad; for although it will for some time to come render the payment of good dividends almost impossible, yet it may at least prevent what has already been spent being practically lost."

The Survey for A Submarine Cable between San Francisco and Honolulu, executed under a special appropriation made by the U. S. Congress has been successfully completed. The laying of this cable,

if carried out, will present some difficulties. The survey has developed some peculiarities in the ocean bottom. The peculiarities of the Californian coast and other matters of general interest in connection with this projected cable have been briefly but comprehensively stated in the *Western Electrician:*

"It is considered quite impossible to run a cable from San Francisco direct, for the reason that a plateau extends out for a distance of about 60 miles, with an average depth of only 100 fathoms; but at that point the depth suddenly increases to 1200 fathoms, proving the existence of a precipice. The whole coast of California does not offer more than a half dozen places suitable for a cable landing. But comparatively few stretches of sandy beach, free from outlying rocks, exist along the coast, and by far the greater portion of the shore waters are shallow, and the bottom is besprinkled with sharp rocky projections. In the Bill making the appropriation, Congress designated San Francisco as the point from which the cable should be laid, but a poorer location is not to be found on the Pacific coast. It happens, however, that the most eligible site existing is the one nearest San Francisco. This place, which is generally known as Moss Landing, though the Government charts designate it as Salinas Landing, is almost in the center of the long, clear, sandy beach circling Monterey Bay, and at a point about one mile south of the mouth of the Salinas River. The bay has practically no shipping traffic, hence no injury is to be feared from dragging anchors."

An Electric Fire Extinguishing Apparatus is another English invention. A reservoir of a chemical solution that extinguishes fire, is placed in a suitable position to sprinkle its contents into an apartment. In this reservoir is placed a cartridge. An electric thermostat with an open circuit is placed in the room and set to close the circuit at any desired temperature. The thermostat is connected by a wire to the cartridge in the reservoir. In case of fire in the room the cartridge is exploded as soon as the temperature rises to the point at which the thermostat is set to close the circuit. The cartridge is then fired off, and this opens a valve for the discharge of the extinguishing solution. At the same time another wire is put into circuit for sounding an alarm at any point desired.

Apropos of Trees Struck by Lightning, of which something has been said in this department, calling out some correspondence in our department of Comment and Criticism, is the following story paraphased from *Le Monde des Plantes* in the Electrical *Review* (London), with comments. It appears that the writer in *Le Monde des Plantes* thinks the lightning stroke developed in the tree in question, "a super-excited vitality," an opinion which our English contemporary challenges:

"About two years ago, at the end of the month of September, a large tamarind tree was struck by lightning at Kumbakonam in India; and fifteen days afterwards the tree burst into bloom; but whilst every branch was laden with blossom not a leaf was to be seen. When the time came for its normal flowering, the tree developed a second crop of blossom, and then, as though exhausted with the strain, it died. We think it is scarcely allowable for our contemporary to argue from this isolated instance that the electricity had produced a sort of super-excited vitality. If such phenomena had been observed in a large number of similar instances, then some deductions might be attempted. As it is, the isolated fact proves nothing, and may be merely a remarkable coincidence, or an example of abnormal behavior. Even though the tree had not been struck by lightning, an accident which we should have thought would have decreased its vitality, it might still have experienced this kind of abnormal flowering. How would our contemporary explain the following facts? The white hawthorn flowers in May, yet the Glastonbury thorn produces May-blossoms, almost unaccompanied by leaves, at Christmas time, and then flowers again in May."

An Extension of Telegraph Communication in Spain is likely to be important. The *Evening Standard* (London), says that the Spanish Government has elaborated a comprehensive scheme for such extension and that, for carrying it out operations on a large scale will be immediately commenced. Several new lines will be constructed. One, Barcelona to Bilbao, will place Barcelona in direct communication with cable to England. Another from Trun to the Portuguese frontier will put Portugal in direct communication with France. The scheme comprises the erection of 350 new telegraph stations.

MINING AND METALLURGY.

THE Fearful Accident by the Explosion in the Osage Coal Mine, near McAllister, Indian Territory, the news of which was flashed over the wires on the morning of January 8, and in which about one hundred miners were killed and 115 more injured, some of them very seriously, again attracts attention to the great danger attending the occupation of coal mining. Statistics are not at hand to make an accurate comparison, but it is highly probable that the number of miners killed in proportion to those employed in getting coal is on the average at least equal to the death rate among soldiers in active military service. At present writing the cause of the explosion is not known. The explosion was one of enormous violence, as is evidenced by the fact that men standing above ground were thrown down by the force of the explosion, and that the effects upon the immediately surrounding country were similar to those of an earthquake. It does not seem creditable, in view of the wealth of mechanical and engineering resources at the present day, that disasters of this kind should be so frequent. That they are so, indicates a parsimonious management rather than any fault in engineering ability. Carelessness and want of discipline in mines also contribute their share to the causes of accidents. It is of the utmost importance that coal should be cheap, and that to this end the expenses of working mines should be reduced to the minimum possible without disregard of the lives and health of the workmen. The past few years has seen legislation directed to the prevention of accidents on railways, and the effect of this legislation has been beneficial, although in many instances it has not been effectively enforced. The writer is not one of those who believe that legislation is a cure for all evils, but there are some things connected with the working of mines which might be enforced by law that would, in all probability, much lessen the frequency of such accidents. Some of these means have been recently pointed out in this department. The electric lighting of mines seems particularly feasible; and if glow lamps were employed for the purpose, there could be scarcely any danger of the ignition of gases through their use. The laying of dust in mines has also been discussed, and there is no doubt that a dusty mine is always a dangerous place. In the instance of the accident under consideration the company have suffered a severe damage financially, as many of the tunnels are said to be entirely closed, large rocks have been hurled down and the interior of the mine has been otherwise badly disarranged. Few have ever had any opportunity to really appreciate the horror of such accidents as these in the immediate scene of their occurrence. It is to be hoped that opportunities for such appreciation will became fewer with advancing civilization.

As to the Unreliability of Cast Steel, the annual report of Chief-Engineer G. W. Melville, U. S. N., contains some important information. He asserts that "the only reason for using cast steel instead of cast iron is that advantage may be taken of its greater strength to reduce weights. There can be no greater absurdity than to make steel castings of the same size as those of cast iron with a view to greater safety, if the strength of the iron casting is ample; steel castings cost four or five times as much as iron ones, and it would be a deliberate waste of public money to use material in this way." As an instance of the small progress in the making of reliable steel castings, Chief-Engineer Melville cites the attempt to apply such castings to perfectly plain hollow columns in a certain ship. He asserts that "in cast iron" these "would have been the simplest kind of work; in cast steel every one was so imperfect that they could not be used. After the failure of these columns the steel

makers claimed that they were of a shape impossible to cast in steel; but before the castings were found defective, not one of the makers thought there would be the least trouble in making them." However, as in other lines of work it has been possible to discover causes for failure and to remove them, Chief-Engineer Melville expresses himself as "inclined to believe, that in time, this will be done for steel castings, since one firm has already successfully produced forms that the other makers said could not be cast, and their manager has stated that it is simply a question of time and the education of superintendents and workmen before we can safely count on the production in cast steel of any form now made in cast iron."

The Application of Electricity to Gold Mining forms the subject of an illustrated article in the issue of the *Western Electrician* for January 2. A large and handsome engraving shows an amalgamator designed by Mr. E. S. Bennett of Denver, and located at Arvada, seven miles from Denver. The successful operation of this machine, which appears to be conceded, is stated by Mr. Bennett to be almost incredible to him, as its parts were built in more than "forty different shops located all over the country. Builders made mistakes and caused delays; parts were found to be imperfect and unsuitable; but when finally assembled the machine was put at work," and, it is stated, with very encouraging results. All power for the amalgamator comes from electric motors located on the body of the machine. A house is built upon the machine for the operator, containing all the necessary switches and other appliances for controlling the operation. Electric current is obtained from a power house, and although the machine is stated to be working on ground so poor that, by ordinary methods, nothing to speak of can be extracted from it, the electric amalgamator is now earning enough to pay for its operation.

From the Colorado Mines, Reports are decidedly rose-colored. The output of these mines for the last year has been greatly in excess of that of any previous year. The character of the men in the business may now be compared with those in any other legitimate trade. Not only is business integrity maintained at a high standard, but the conductors of the mines are by education and business methods competent to take their place among those in any other kind of business. The miners themselves are also of a much higher grade than could be obtained in former years for such work. In methods, the most advanced means and appliances are used, and the subject of economy in the getting out and milling of the ores is constantly studied. A most favorable element in the business is that it is strictly on a cash basis. Returns are quick, and the amount of capital necessary to conduct a paying business is therefore smaller than is required for the conduct of other business promising an equal or even a less profit. The advances in mining in this State serve to indicate that the mineral resources of the State are enormous. Notwithstanding this, it has been shown, that large as the mining industry is in Colorado, that of agriculture surpasses it in the value of its products.

A Non-oxidizing Process of Annealing is described in the *Engineering News* in its issue of January 2d in an article of three and a half columns, which is altogether worthy of the perusal of any one interested in metal working. It is regretted that our space will only permit of a very brief mention of this process. All are familiar with the ordinary process of annealing, in which the metal in its heated condition becomes more or less oxidized. This oxidation is objectionable in many instances, and the process described in our contemporary has in view the providing of a simple, practical and inexpensive method by which metals may be annealed without oxidation. The principal feature of the process which is ascribed to Mr. Horace K. Jones of Hartford, Conn., consists of a retort in which the articles to be annealed are placed, and which is kept filled with a non-oxidizing gas by connecting the interior of the retort with a gas-holder or gas-main during the entire process of heating and cooling. The heating of the gas does not injure it for any purpose to which it

may be subsequently applied, consequently there is no material loss in the process, as after the gas has passed through the retort, it may be conducted immediately back to the main from which it was extracted. It is stated that the process has passed already through its experimental stages, that its utility has been thoroughly demonstrated, and that "being purely mechanical, any workman of fair intelligence may attain the best results."

Sapphires and Rubies appear likely to become the basis of an important mining industry in Montana. The Sapphire and Ruby Company of Montana, according to the Helena *Independent*, has been organized by English capitalists, who, after thorough inspection, have acquired 8000 acres lying on both sides of the Missouri River. It is asserted that mining operations are to be commenced soon. Two of the English directors of this company are stated to have recently come over to examine and report upon the value of the property, and they are claimed to have asserted that all the representations made to them abroad are more than justified. They are said to have taken with them back to London specimens of gems exceeding in beauty and value any of the same kind previously exhibited there. In fact, one of these directors, Mr. Streeter, is said to be a London jeweler and an expert in gems. All this is given for what it is worth, and further developments are awaited.

The Formation of Natural Gas, according to Prof. W. J. McKee, of the United States Geological Survey, is constantly going on. According to this authority it is easy to predict the success or failure of any prospective bore for oil or gas. Every great field, whether in Pennsylvania, Ohio or Indiana, has under the surface of the ground a mass of porous sandstone or limestone. These fields are called "domes" by Professor McKee, and he states that the coarse-grained limestone forms the reservoir of inflammable fluids. He claims that both oil and gas were originally formed by the slow decomposition of organic matter. In all places where the drain is greater than the rate of formation the supply will ultimately fail. While Professor McKee predicts that the anthracite of America will be consumed in a comparatively short period, the bituminous deposits in the rocks of the earth are practically infinite, and the fuels and illuminants of the future will be derived from these deposits.

Of Silver Ores at the World's Fair, the *Mining and Scientific Review* states that in connection with the gold exhibits there will be shown a fine collection of silver ores from Colorado mines. Among these will be cubes of silver from the Minna mine on Mineral Hill; a block of silver from the Ida Alice mine on Bowlder creek; large blocks of ore from the Blind Tom mine near Dillon; two big black-looking cubes from the Pennsylvania mines, near Decatur, which assay 500 oz. of silver and 15% of lead to the ton; some odd-looking specimens of red ore from the Ouray mine, nerr Breckenridge, that assayed 1650 oz. of silver to the ton; a specimen from the Silver King mine, near Montezuma, rich in galena, copper, silver and gold, assaying $140 per ton, and a big 200 pound block of silver ore from the Snow Drift mine, near Breckenridge, that assays 2000 oz. per ton.

Some Very Inexpensive and Successful Blasting according to *Engineering News*, has been done by Mr. C. L. Kahlback at the Little Passaic Falls a short distance above the Main Passaic Falls at Paterson, New Jersey. Pure blasting gelatine was the explosive used. Its cost was 50 cents per pound. Dynamite could have been had for less than one-third of the money, but the results have been that "8000 cubic yards of hard seamy trap rock, every hole in which was full of water," were taken out by the use of "only 1400 pounds of explosive." *Engineering News* states that "hardly a single stone was thrown more than 20 ft., yet the rock was very completely shattered." It was estimated that to take out the same quantity of rock with black powder would have cost from $25 to $30 per cubic yard.

An Interview with Stanley, the explorer, has been published in the *Australian Mining Standard* with reference to the future of mining in Central and East Central Africa. Six exploring expeditions are now prospecting with the view of

discovering minerals, their expenses being defrayed by the Congo Government. It is expected that gold and copper will be found in abundance. Each party is accompanied by mining experts. Of course, the results of these expeditions cannot yet be known, but Mr. Stanley's knowledge of the country, his statements that Arabs in the country have been seen in possession of vials containing gold dust, and that plenty of copper ore is not only to be had, but the smelting of it is evidently known to the natives, encourage the belief that in this region important mining operations are likely to be inaugurated in the near future.

Two New, Hard Steel Alloys for the manufacture of boring and cutting tools have been recently produced according to a statement made in *Industries* (London), in its issue of the 25th December. The most remarkable characteristic of these alloys, if it really belongs to them, as asserted, is that they do not lose their hardness when heated by friction. The composition of each is given, that of the first being pig iron, 17.25 parts; ferro-manganese, 3.00; chromium, 1.50; tungsten, 5.25; aluminum, 1.25; nickel, 0.50; copper, 0.75; bar iron, 70.50; in 1000 parts of alloy. The second is composed of pig iron, 17.25 parts; ferro-manganese, 4.50; chromium, 2.02; tungsten, 7.50; aluminum, 2.00; nickel, 0.75; copper, 1.00, and bar iron, 65.00 parts in 1000 parts of alloy. Both alloys are made by first melting the pig iron, ferro-manganese, chromium and tungsten together in a graphite crucible under charcoal and borax. The metal thus obtained is remelted in a clay crucible and the bar iron, nickel, copper and aluminum are added, the smelted metal being then covered with charcoal only.

Silver Mining in Australia appears to be in a depressed condition. According to the *Australian Mining Standard* a great slump in silver shares occurred during the past summer, due to the fact that the expensive nature of silver mining began to be realized when solid work was undertaken. It states that, with a few interruptions, a gradual shrinkage of almost every silver mining stock has occurred. Even the dividend paying mines have slowly developed a decline in the price of their shares. The result of this is an almost entire cessation of speculation. The decline is traced also to other causes besides the expenses developed in the opening of new mines; as, a commercial depression which has prevailed in the colony, and the action of Melbourne and Adelaide brokers who have been raiding the market. Notwithstanding all these disturbing influences, the journal quoted does not hesitate to advise the public to buy mining shares, as it thinks, that although the rates may go lower, the outlook is favorable for much better prices in the near future.

Graphite of Rich Grain and in large deposit has been discovered in Providence, R. I. The vein of this mineral is said to vary from 10 to 45 ft. in width, with, as yet, an undetermined length. It is stated that preparations are made to increase the output, now about four tons per day to one hundred tons per day. The *Manufacturers' Record* in discussing the value of this deposit asserts that "there is no Eastern plumbago mine which has proved as prolific as this one bids fair to. The Eureka mine, a large establishment at Sonora, Cal., yields but 1000 tons per month." The mineral has been found well adapted for foundry facing, and it is stated that the present product is all marketed in the West for that purpose. Tests of its adaptability for painting indicate that it is also well adapted for that purpose.

Gas-Wells Sunk in the Vicinity of Salt Lake City have, according to the Salt Lake *Tribune*, produced quite an excitement in that enterprising town. A statement from a prominent real estate man from that city who has had experience in the oil and gas regions of Pennsylvania is quoted as giving the opinion that before this year expires gas-wells will be sunk all over the valley. The expense of sinking wells is said to be extremely low, the character of the strata allowing a depth of 1000 ft. to be bored at an expense of only $1000. If these anticipations be realized there remains undoubtedly a commercial boom for Salt Lake City. "Westward the star of empire takes its way."

MECHANICS.

THE New Safety Clutch of Siemens and Halske is a new application of electricity to the working of an old mechanical device which has in all the elements of practicability, and commends itself to good mechanical judgment. On either side of a pulley, which gives off power from a shaft and which may turn freely thereon when not connected with the shaft by the clutch, are arranged two electro-magnets of annular form. One of these is firmly attached to the bearing of the shaft or to an independent support. The other is keyed to the shaft and revolves with it at a very short distance from an internally conical rim or projection formed concentrically with the belt-rim of the pulley. An electric current sent through this magnet strongly attracts the pulley toward it, and the conical projection on the pulley fits over the exterior conical shape of the magnet. The attraction is so strong, that in conjunction with the wedging action of the cone-surfaces, the pulley forms a frictional connection with the shaft and is turned with it to transmit power. The fixed magnet is used only as a brake in cases where it is necessary to stop the motion with great rapidity. In this case the current, which passes through the magnet keyed to the shaft, is broken, and a powerful current is sent through the fixed magnet. This draws the pulley toward the fixed magnet which acts as a powerful brake. The shunting of the current to the fixed magnet, and the breaking of the circuit to the one which is keyed to the shaft is effected automatically by a switch controlled by a small relay magnet.

The Reminiscenses of Enginemen who ran at the front for either Army is sought by the editor of the *Locomotive Engineer*, who states that "the experience of those days reads like novels to us younger men." This remark is made in a note to a contribution from Mr. C. J. H. Hevey of East Rome, Ga., who describes "an old carbody now used for a tool-house, bearing on its weather-beaten sides this legend: 'U. S. Military Railroad, Engineering Department;'" and in an interesting manner he recalls many of the circumstances which attended railroading in war times, giving a list of engineers who were at that time running out of Chattanooga. The following quotation is an interesting sample of these reminiscenses:

"Up to July 16, 1864, we ran by orders something after this style: 'Engines Nos. 133, 134 and 135 will meet engines Nos. 126, 128 and 129 at Graysville.' There was no superiority, the orders were emphatic, and no trouble ever experienced, rear collisions few. All trains were supplied with a train guard of soldiers, who soon became expert brakemen, so that trains at the slow speed we ran, could be stopped very quickly. For fear of becoming tiresome, I will shut off by telling you that myself and Charley Briggs, with Conductors Ostin (Legs) and Jas. Sanderson (Three-fingered Jack), with Baldwin Engine 26, hauled the timber for the historical bridge built by McDonald over the Etowah River, under penalty of being placed in the front ranks with a musket if he did not finish said bridge in a very short specified time. Mc. saved his 'bacon,' and had about 13 hours to spare. I ran the engine over the bridge that number of hours ahead of Sherman's schedule. I also ran many times over the celebrated pole bridge built by General Rosecrans across the gap on Sand Mountain.

"Should this meet the eye of any of the 'old-time' government locomotive engineers that ran out of Chattanooga in '64 and '65, I would like to hear from them. They can reach me through the columns of *The Locomotive Engineer*, or address Dummy Engineer, East Rome, Ga."

The Disposal of Smoke, as proposed by Dr. Sheridan Delépine and Mr. Gomess, of the Chemical Section at the recent Congress of Hygiene and Demography, was exemplified by a model apparatus exhibited by them on the occasion referred to. The apparatus burned turpentine, which as is well known, is a very copious producer

of smoke during combustion, and the chimney of the model being capped so that no smoke could escape in the ordinary way, its disposal was accomplished by a descending flue connecting with the chimney and ending with a valve leading to the sewer. The valve is so arranged that any tendency to regurgitation of gases from the sewer is checked when the apparatus is not at work. The forcing downward and into the sewer of the gases of combustion is accomplished by a series of water jet-pumps and exhausters, the operation of the pumps being based on the action of intermittent siphons. It is stated that the experiment demonstrated the fact that a fall of only a few inches of water was sufficient to insure the rapid removal of the smoke, and that the water can be used over and over again provided the difference in level between one set of pumps and another set is at least 4 or 5 feet. A collateral advantage claimed for this method is that it introduces into the sewage the disinfectant products contained in the smoke.

A Criticism of Modern Technical Education is made in the *Mechanical World* (London), in which it is alleged that there is at present a deficiency in skilled workmen, caused by the idea that the facilities afforded in technical schools are insufficient to qualify those who pass through them for the exigencies of future mechanical work. The writer alleges that our colleges are turning out book engineers in swarms, most of whom cannot undertake the simplest work of a practical character, and that we are thus becoming overwhelmed with theorists devoid of skill and thoroughly incompetent as workmen. The assertion is broadly made that among all these college-trained engineers not one in fifty is really competent to undertake work of importance because of their lack of all practical knowledge. These remarks apply to English workmen, but that there is an element of truth in them as applied to the graduates of American technical schools will be confessed by those who have had experience in the employment of their graduates. The fault is, however, not in the schools, but in those who, availing themselves of their advantages, do not make the most of them. Too much time is spent in hazing and in the popular college amusements. Students forget that engineering is a long road, and that eminence in it, as a profession, can only be acquired by the most rigid application. This view is confirmed by the fact that some of the most skillful engineers now practising in the United States are graduates of such schools. It is to be admitted that in comparison with the many who so graduate, the eminently successful ones are few; but this is true of the graduates of classical institutions as well. Schools alone, no matter how good they may be do not make successful men. The successful man is the one who, with fair ability at the start, earnestly and industriously strives for success at all times and in all places, making his profession the paramount consideration. This accounts for the eminent success attained by many who have never had the advantages of college education, and applies to all professions without any exception. There have been eminent mechanicians, lawyers, physicians, engineers, who, so to speak, have been self-educated. This would be more properly expressed by saying that with a constant purpose to know all that could be known about their profession, they have been educated by every collateral circumstance of their lives, as well as by every event immediately pertaining to their professions. Their minds have been kept in a constant state of receptivity, and their powers of observation are always on the alert; thus nothing of importance escaped them, and their attention was never permitted to be diverted from the main purpose. Another reason for defects in the graduates of technical schools is the fact that parents and guardians often require their attendance by young men, who, by the very constitution of their minds and their general character, are utterly unfitted to adopt engineering as a profession. The same mistake is made in this, as is common all over the country, in the useless payment of large sums of money for the instruction in music of those who have no natural talent for the art. The schools are many of them

admirable, and admirably equipped for their work. It is not their fault that so many of their graduates fail to justify the hopes of those who have supposed them to be what they could not possibly ever become, places wherein the unfit can be fitted for something by mere force of environment.

Of the Steel Works Club, established by the Illinois Steel Company, and partially maintained by it for the benefit of 2000 or more workmen in its employ, the *Railway Age* speaks, in an account of the second anniversary of the club recently held in its spacious hall at Joliet, Illinois. All will recognize the picture in the following extract from the journal named as characteristic of a grade of workmen above that ordinarily seen in such gatherings; and if the result of the organization of such clubs is to improve the status of its members to the extent indicated, it is to be hoped that other large works throughout the country will imitate the example of the Illinois Steel Company.

"No one who looked down from the platform upon the gathering of men and women filling the spacious hall of the Steel Works' Club at Joliet, Ill., last Saturday would imagine, without previous knowledge, that the audience was composed of the laborers in a great steel manufactory. Instead of the grimy, half clothed, toil worn, almost fierce looking beings whom the visitor to a rail mill beholds rushing to and fro amid the flame and smoke they saw clean shaven, well dressed and intelligent looking men, mostly young or in middle life, accompanied by their wives, mothers and sisters, listening attentively to the addresses and showing by hearty applause that they understood and endorsed the frequent allusions to the identity of interests between labor and capital."

From the article quoted we learn that the Company have "built a noble and spacious stone structure, containing a library; lecture hall; art rooms; gymnasium; bowling alley; hand-ball court; billiard room; game room for chess, checkers, etc., and, not least of all, numerous and comfortable bath rooms with a large swimming tank in addition." The building and all its equipments have been donated by the Company to the employés. The Company pays all the taxes, the salary of superintendent and librarian, the cost of lighting, heating and repairs. Members of the club pay the nominal fee of $2.00 per year. A sensible course of education has been provided. Shorthand, arithmetic, penmanship, free-hand drawing, bookkeeping, gymnastics, sewing for girls, and mechanical drawing for adults are taught. In addition there is a free kindergarten for children. The adults pay a small tuition fee for instruction.

In Aeronautics much interest is now apparent. Pennington, whose company organized at Mt. Carmel, Ill., for $20,000,000 to exploit his scheme, seems to have been chiefly successful in putting forth sensational reports, among which the latest is that he has purchased a tract of land in Kentucky containing aluminum clay, and has paid or agreed to pay $300,000 for it. It is said he proposes to make aluminum out of this clay, and that his future airships will be built out of the aluminum. Meanwhile others are doing more than manufacturing reports. In another place is stated what Mr. Hiram Maxim is doing.

The Smallest Wire in the World, according to an article that recently appeared in the New York *Sun*, is made at Providence, R. I. This wire is made by the use of diamond dies. In regard to the manufacture of the dies some very interesting facts are given. Rubies and sapphires were the first substitutes for metal dies, but notwithstanding their superior hardness, they altered in form by use. The next step was the drilling of diamonds by which better results were gained, but still the results were imperfect, the holes so drilled being rough and leaving their marks upon the service of the wire. At last it was discovered that the holes, after drilling, could be reamed out smooth and this resulted in a perfect die. The article states that the American Electrical Works were the first to manufacture such dies in the United States. Through them wire may be drawn finer than a human hair. Such wires are used in making receiving instruments for ocean cables, galvanometers for testing cables, etc. The smallest size yet made has a diameter of .002 of an inch, and of this wire it takes 16 miles in

length to weigh a pound. Notwithstanding the smallness of this wire it is wound with two layers of silk thread of smaller diameter than the wire, and the process of winding is said to be one of great delicacy. The wires are made of copper and German silver. The diamond dies are set in brass and held by an alloy melted and poured around them. The diamonds are chips which are broken off from the large diamonds by lapidaries in cutting jewels. Since it has been discovered that these may be utilized in making dies for drawing wire the demand is increasing more rapidly than the supply.

The Scientific American Cyclopedia of Receipts, Notes and Queries, edited by Albert A. Hopkins, and published by Munn & Company, of New York City, price $5, is a thick, octavo volume of notes, queries and correspondence, recipes, etc., compiled from the columns of the *Scientific American*. In its long and honorable career this popular weekly newspaper has received communications containing practical experience in almost every department of industry. These have sometimes been crude, but it is easy to see how an able compiler and experienced editor as Mr. Hopkins is known to be, would be able to separate the crude from the pure metal and thus to produce a volume of great value. As the frequent use of the names of chemicals is necessitated in the book, a table of chemical synonyms in an appendix, which also contains tables of weights and measures, adds to the usefelness of the work. The topics are arranged alphabetically, as in dictionaries, and are therefore exceedingly easy to find, this arrangement moreover making an index entirely unnecessary.

A Fishy Statement is made in *Iron* with reference to the effect of sunlight and moonlight upon edged tools. That paper says that knives, drills, scythes and sickles assume a blue color if they are exposed for some time to the light and heat of the sun; and that the sharp edge disappears and the tool is rendered absolutely useless until it is re-tempered. It moreover asserts that the effect of moonlight is similarly deleterious. As an exemplification of this alleged fact is cited a saw said to have been spoiled in a single night by exposure to the light of the moon. All this, of course, is nonsense, and it is simply cited as showing the sort of nonsense which frequently gains currency not only in the daily papers but in many so-called technical publications.

A Remarkable Instance of the Duration of Steel Tires is mentioned in the *Railway Age*, a tire having been exhibited in the Grand Pacific Hotel at Chicago, which is said to have run 60,000 miles in the passenger service of the Indianapolis, Decatur and Western Railway, and, notwithstanding this service showing only $\frac{1}{32}$ of an inch wear. The fact is pointed out that this is about 40,000 miles to the sixteenth of an inch wear, or about three times the average good mileage of steel tire. The statement made about this wear is so extraordinary that the editors of the *Railway Age* wrote to Mr. John McKenna, master mechanic of the railway named, to verify the statement. The reply from the master mechanic was to the effect that the statement was not only correct, but they had three pairs of wheels more, doing just as well.

Enormous Belts, said to be the largest ever made in New England, were those manufactured for the power station of the West End Street Railway Company on Albany Street, Boston. Of these belts 12 are 150 ft. long and 54 in. in width. It is said to have taken 79,200 pounds of leather to manufacture them. Each fly-wheel carries two of these belts, thus making a total width of 108 inches. The Boston *Weekly Transcript*, from which we have taken these figures, states that this is supposed to be the largest belt-service ever used on a single fly-wheel. Besides the 12 belts named, 24 others 30 in. in width are required to run the generators. These are also made double, and the amount of leather required for them was 27,000 pounds.

Importation of Spanish corks into the United States is stated to have ceased since the MacKinley bill went into force, notwithstanding which the industry still prospers, as a good market is found in England and Norway.

POPULAR MISCELLANY.

A SCHEME of Co-operative Observation of the so-called Luminous Clouds is proposed in an interesting article published in a recent number of *Nature*. This article calls attention to the fact that since 1885 on summer nights and in both Northern and Southern Hemispheres curious cloud formations have been observed, and that they have an evident connection with the great volcanic eruption at Krakatao which occurred in the year mentioned. That these clouds are situated at very great distance above the earth's surface is deemed to be demonstrated by the intensity of their brightness when considered with reference to the position of the sun at the time of their observation. The distance from the surface of the earth at which they are suspended is estimated to be more than 80 kilometres, and it is supposed that they consist of a kind of dust or particles which were projected to a very great height at the time of the eruption. Their rose-color is attributed to their illumination by the sun's rays for a considerable period after its disc has disappeared to people upon the surface of the earth. *Nature* deems that it would be "more important that these phenomena should be carefully and widely observed, since it is believed that the clouds are gradually breaking up, and that in a few years no distinct traces of them will remain." At present, these clouds are beginning to assume the appearance of "thin whitish-blue shining veils," and *Nature* deems it probable that they are now no longer to be seen at the zenith as was the case upon their first appearance. Although these luminous clouds differ in shape and structure from other kinds of clouds, there is danger of mistaking ordinary cirrus for luminous clouds when the cirrus clouds are exceptionally bright. The luminous clouds, however, most generally can be distinguished from any other clouds from their comparatively greater stability of position; for, although they are known to be in motion, their great distance from the eye makes them appear almost stationary as compared with the lower clouds of aqueous vapor.

The Manufacture of Lactic Acid is a new industry which according to the *Chemical Trade Journal* is likely to be carried out on a very large scale. When it is reported that this acid was formerly much used in dyeing, being derived from milk soured for the purpose, and that it was in its time an extremely useful material, only superseded by cheaper mineral acids, the importance of the artificial production of the substance at a price which can enable it to compete with the hitherto cheaper acids, will be appreciated. This acid has also been much used in pharmacy for dyspeptic complaints, and the artificial supply promises to afford it at such price as to make its use in acid beverages very popular. The *Chemical Trade Journal* expresses the opinion that it may supplant vinegar for culinary and table use, as it is, in many ways, a more agreeable acid, and its dietetic value is well recognized. The chemical process by which the ordinary acid is produced is too technical for discussion in this place.

A Remarkable Experiment in Naval Ballooning has recently been carried out in Bombay by Lieutenant Mansfield, of the Royal Naval Reserve. Ascending from the Victoria Gardens in that city, seated upon a trapeze to which a parachute of a new kind was attached, he rose to a height at which the balloon was scarcely visible, and which his barometer showed to be an altitude of 11,400 feet. At this point he was so cold that he was unable to feel the cords with his hands. The rest of the adventure follows, as reported in the English papers shortly after the event: "Finding his apparatus all clear, he took the balloon ring in his right hand, drew himself clear of the trapeze, and dropped down into space. After descending with terrible velocity for some distance the parachute began to open. At 10,200 feet he

was falling at great speed, but was fully able to control his apparatus. At 10,000 feet he was sailing down calmly in space. Then he drifted to and fro in various counter currents, and at 1000 feet exactly, felt the heat from a long, red, iron chimney. Steering his parachute to the eastward he dropped her rapidly to clear the buildings ahead, and seeing nothing but houses to descend on, he selected the flattest he could find, and dropped gently down on it." It appears that the parachute by which Lieutenant Mansfield descended is provided with what he calls valves, by which he can guide his descent and make a landing where he chooses. His balloon in which he made his ascent drifted out and descended in the sea, from which it was recovered, having been provided with cork belts for holding it up. This new parachute is considered as likely to be of great advantage in future naval and military operations. The inventor, however, announces, that as applied to military warfare, the parachute will need some modifications which will be supplied by him and tested in future experiments.

A Remarkable Run of a Steamer on full speed, being a distance of 12,059 miles, without once slackening off the engines, has been recently made by the Steamer *Tekoa*, belonging to the New Zealand Shipping Company. This vessel is employed in the transportation of meat, and the run made was between Teneriffe and Auckland. The average speed from London to Auckland, a distance of 13,772 miles, was 10 knots per hour, the consumption of coal for all purposes, including electrical and pumping engines, being only 21¼ tons per day. The actual steaming time was 58 days, 2 hours; and it is stated that during the latter part of the voyage considerable bad weather and rough seas caused a racing of the propeller which was quite annoying. The engines were quite new and the fact that they made 16.000,000 revolutions without requiring any adjustment, is regarded as a very uncommon occurrence. They were built at the Central Marine Engine Works, West Hartlepool, England, and were designed by the celebrated engineer, Mr. Thomas Mudd. The engines are of the triple expansion type, the diameters of the cylinders being respectively 27 inches, 43 inches, and 72 inches, with a stroke of 45 inches. This vessel carries a cargo of 6250 tons. An examination of these figures will show that its coal expenditure was only 4 cwt. for every ton of cargo carried over the distance of 13,772 miles.

The Flying Machine now in process of construction, designed by Mr. Hiram Maxim, has been described by him at a recent annual meeting of the Aeronautical Society of Great Britain, from which description it is gathered that the machine is now fully equipped with its motor, this being a compound steam engine of very light construction. Mr. Maxim claims that for each 10 pounds' weight of engine and boiler and condenser he has been able to develop a useful horse-power as determined by the brake. Mr. Maxim stated that the efficiency of the steering and leveling gear of the machine has yet to be determined, and if found inefficient, to be further provided for. Beyond this he believes he has overcome all difficulties, and that in two or three months he will have completely solved the problem.

An Attempt at Photographing the Expression of the Human Countenance during speech, that is to say, the obtaining of a series of such photographs at very frequent intervals, has been made in France, and promises in its development to give us something interesting. At present the results are not very satisfactory, but progress is to be expected in this as in all other innovations. The movement of the lips in pronouncing the words, "I love you," have been taken in a series of 24 photographs. These 24 phases of movements are repeated in pictures about half as large as a postage stamp. *The Photographic News* in commenting upon these pictures thinks that not much can be made of them without the knowledge of the words uttered during the movement of the lips. It is well known that deaf persons may be taught to understand speech and interpret language by watching the movement of the lips alone, and when the organs of speech are perfect, that they

may be even taught to converse with others, sometimes so perfectly, that a stranger may be deceived, and for a considerable time fail to discover the defect in hearing. What may grow out of this experiment no one can at present predict.

The Reading of THE ENGINEERING MAGAZINE in the most remote points where the English language is used is indicated by the fact that it has received an excellent notice in the columns of *Indian Engineering*, published at Calcutta. That journal is pleased to say, that while engineers can "pick up many hints from its pages, the general reader can also join with pleasure and profit without any fear of the treatment of the subjects being rendered unintelligible to him by equations and diagrams." Speaking specially of Mr. Saunders' article in the July number entitled "A Survey in a Diving Suit," it quotes what Mr. Saunders said of Mr. Ray the colonial surveyor, to the effect that he was "more of a society man and army officer than an engineer," and also that it was "really a matter of doubt whether or not the colonial surveyor could tell the difference between a theodolite and a thumbscrew," as being perfectly applicable to many heads of English Colonial Departments.

The Immense Grain Traffic of the present year has been summarized in the *Marine Review:* "Buffalo received by lake during the season just closed 129,193,020 bushels of grain and 6,322,490 bushels of flaxseed. The city elevator at Buffalo alone handled 33,500,000 bushels of grain. The aggregate of receipts was 40,000,000 bushels larger than last year and 24,000,000 bushels larger than during 1880, which held the record up to the past season. Receipts of flour were 7,093,340 barrels, also beating the record; last season's receipts were 6,245,580 barrels." Of other shipments received at Buffalo there were of lumber, 262,729,000 feet against 282,251,000 feet in 1890, a falling off of nearly 20,000,000 feet. Of iron ore there were received 419,890 tons as against 551,940 tons last year. The shipments of grain by the Erie Canal show a falling off of nearly 4,000,000 bushels, being this year 34,267,000 as against 38,218,960 bushels last year. The shipments of coal by lake were this year 2,436,330 tons. In 1890, 2,157,810 tons were shipped.

The Usefulness of Public Libraries is indicated by some statistics relating to the use of public libraries in Manchester, Eng., for the year 1891, which have been compiled in *Nature* from the 39th annual report of the Library Authorities to the City Council. It appears that during the year there were 4,327,038 visits of readers to the reading rooms as against a total of the preceding twelve months of 4,195,109, and that the number of volumes let out for home reading was 702,803. A remarkable circumstance attending the loan of these volumes is, that out of the immense number only 13 were missing at the end of the year. Doubtless this statement cannot be excelled by the records of any American library. The only library in New York City which is at all comparable in popular utility to the circulating libraries of Manchester is the Mercantile Library. The Astor Library is available to comparatively few, on account of the inconvenient hours during which it is kept open. The Columbia College Library, one of the most valuable reference libraries in this city, is used mostly by the students of that institution. A few outside readers are, however, admitted to its privileges, on good recommendation, by free tickets.

Mr. Edward Atkinson, notwithstanding he is understood to be an extremely busy man in walks outside of literature, still finds time to do a large amount of excellent literary work, being a contributor to many prominent publications. We need not call the attention of our readers to articles which have appeared from his pen in our own publication, and simply remark that this comment is called forth by the perusal of an excellent article on banks and banking, which was published in the *Manufacturers' Record* in a recent issue and has well repaid reading.

Damage to Eyes through the use of the microscope is shown to be possible by a communication from Mr. G. K. Gude to *Nature*, published in a recent number of that able journal. Mr. Gude says that his

eyes were originally equal in power, but while the right eye is now of normal power, his left is deficient in distinctness of sight. He attributes this fact to working at the microscope with the right eye without closing the left, and he notices that while he is at work in this way the defective sight of his left eye becomes particularly noticeable. This statement points clearly to the desirability of using binocular microscopes in preference to those having a single eye-piece.

The New Building of the Institute of Technology at 147 Throop Street, Chicago, according to the *Architect and Building News* of that city, has been built almost wholly by the students of that institution. The practical character of the school is demonstrated by this fact. The journal quoted announces that the plan of the school is to teach "*any person any study day or evening*." This interesting statement is concluded by the announcement that evening-classes in electricity, plumbing and brick-laying, architecture, engineering and telegraphy have all been organized. Draughting of all kinds is made a specialty, four instructors being employed.

Compressed Air as a means of transmission of force from a central station, has been carried out in the town of Offenbach, near Frankfort-on-the-Main, the features of the installment being similar to those of the compressed air system in Paris. This is the first town in Germany to adopt a system of compressed air transmission. The air is chiefly used for driving small motors. About 20,000 ft. in length of cast iron main of 26 in. diameter, 5000 ft. of 1 ft. diameter, 5000 ft. of 3 in. diameter, and 13,000 ft. of 4 in. diameter have been laid. The joints are all packed with India rubber. A most remarkable result was obtained upon testing this system under pressure after the pipes were laid. A pressure of 6¾ atmospheres was forced into the system of pipes and kept up for 70 hours with a loss per hour of only 1.9 cubic metres. This shows that the pipes and joints must have been of a very high order of workmanship. The central station is lighted by electricity and contains air-compressing apparatus, engines, boilers, air reservoirs, etc. The pressure maintained is 6 atmospheres. The air is compressed by stages, in one pump to 2 atmospheres, a second compression completing the pressure to 6 atmospheres. The air is cooled during the compression by injection of water into the cylinder and into the receiver into which air is delivered. It is said that 87% of the steam power is realized in the stored-up compressed air. The economy of the steam engine is indicated by the statement that it consumes only 15½ pounds of steam per horse-power per hour.

Of Keely's Critics, *Invention* (London), in its issue of December 12th, speaks with some contempt, at the same time styling Keely "*the Philadelphia scientist*" and "*searcher*," and evidently regarding him as ranking among the great investigators of the age. The article, after having made Mr. Browne's articles in the *New York Herald* the subject of considerable criticism, ends its remarks with the following rather remarkable statement:

"Mr. Keely has chosen the successor of Professor Tyndall at the Royal Institution of Great Britain as the only one to whom he is willing to communicate his method, and it is to be hoped that Professor Dewar will be able to sail for America in the *Etruria* on the 12th instant. (to-day), for which voyage cabins have been taken for himself and friends. This will be welcome news indeed to the scientists on both sides the Atlantic, and the result will be awaited with anxiety alike by both the friends and foes of Keely. We shall watch for the result, as will our American *confrères*."

The Manufacture of Paper is to be well represented at the coming World's Fair, a stock company with a capital of $100,000 having been formed to conduct an exhibition of paper, in which every manufacturer either of paper or of paper-making machinery in America will be permitted to take stock. It is stated that the entire capital has been pledged, but will not be called for until outsiders have had a chance to subscribe, as the idea of making money forms no part of the scheme. As time passes the indications that we are to have a great exposition multiply.

MACHINE-SHOP NOTES.

By Col. Loquial, M. E.

RAILROAD shops differ from almost all others in that there are no outside customers, and that every job done in them bids fair to be back again at some time or other for repair. With this fact in view it is well to have some way of keeping a record of the condition of every engine that is likely to come back, whether it be sooner or later, as a good plan of this sort will do two things—tell the owners of the machine in what condition they are, and inform the shop management what machines are in hand or expected to be in hand. Perhaps the system adopted by the Pennsylvania railroad at Altoona is as good as any. There is a large board which bears on it as many pins as there are engines on the road or division to which it refers; each pin is numbered, and bears on it eight disks of various colors, the outside one indicating by its color the condition of the engine of that number. A pink disk outside indicates that the engine is in good order; one with pink top and red bottom, that it is in fair order; one with a red top and pink bottom, that it requires repairs; gray, that it is in the shop for slight repairs; blue, in the shop for general repairs; a white quadrant on a black disk, that it is rebuilding; a black disk, that the old number is temporarily vacant; and a disk with white top and black bottom refers to a new number as yet unfilled.

This plan may be adapted to the various machines and machine tools in a shop; to the various bridges on a line of railroad; to the various vessels in a line; to the different stations on an elevated or other railroad, and so on.

* * *

So you have broken that hoisting rope! Well, the only wonder is that it did not break sooner. You use too small sheaves. Every rope has some stiffness; any rope of large diameter drawn over a pulley of small diameter must stretch along its outer edge (if the word edge may be used) and be compressed along its inside edge; while there must be friction between the core and the inside and outside fibers. The chafing between the rope and the sheave is only a part of the friction that goes to wear out the rope. If the internal strand, or core, were black-leaded, the casing fibers would slip on them and there would be less of the internal cutting. The original strength of the rope would not be increased, in fact might be slightly diminished, by the plumbago overcoming the friction which alone holds the particles of the rope together in spinning; but the general result would be desirable. Such rope is used with success in large coal hoisting and conveying plants.

* * *

The reason why you are not able to make good malleable-iron castings is that you are too new in the business. It would be cheaper for you to get your castings of that sort made by those who have been in the business a good while and have a good reputation in that line. Their experience has been paid for long ago; you will not have to pay for it when you order castings from them. In the early days of such work, when the malleable iron foundries lost about one out of every three pieces that they made, the purchaser paid for the spoiled ones, whether he thought that he did or not; and probably he paid for some that were not yet spoiled but which might be at the next run, or at some other run in the future. But you are now paying for the spoiled ones that you make. If, however, you *will* insist on keeping on trying until you get matters right, you should use pig that is very free from both phosphorus and sulphur; should melt it in crucibles of from 50 to 100 pounds capacity, away from the air; and should pour it when it is hot enough for a drop of it, taken out on an iron bar, to burn when exposed to the oxygen of the external air. As to the

cementing, there is not much mystery about it; it is more a question of judgment as to how long to keep the pieces in the oxides of iron, the proper temperature, etc. To find out how long and how hot, you will have to pay for the experience.

* * *

That man who is painting those bridge sections should have his brush full of paint slapped across his face as a reminder. He is doing work that will fail and be to your discredit. He has not taken off the scale and rust, as he should have done, with a stiff wire scratch brush. As the paint is only to preserve the work in shipment it would be better not to use paint at all, but to swab the pieces with linseed oil and then work it in well with a stiff brush. The little pieces might be soaked in boiled oil.

* * *

There is a much maligned animal called the jackass. Whenever any one does anything that is not just right, or which some one else thinks is not just right, he gets called a jackass; whereas in many cases it is a libel on the four-footed animal. It would be in the case of the so-called machinist who grinds his cast gears together to make them run smoothly. In order to do the thing about as badly as possible he uses emery or corundum to help the grinding along. The result is that if the teeth ever had any regular shape, or any form at all, other than might be made by getting the print of the ball of the thumb—that shape is all gone. The action of the gears may be smooth enough as regards absence of noise, and as regards freedom from hard running; but if you will set together a train of several such gears and see that the first of them is turned slowly, one tooth at a time with regular velocity, you will find that the last one goes by fits and starts according to just what parts of the teeth are in gear; and the smaller the pinions in comparison with the spurs, the greater the irregularity of the motion. In addition to this, you cannot grind cast-iron surfaces together with emery or corundum without some of the abrasive getting bedded into the metal, there to remain acting as in a lap, cutting and scoring its way into the opposing surface, and thus producing a heating worse if possible than the mere roughnesses that were considered objectionable.

* * *

Not that rough gear teeth are to be praised or even countenanced; but the best way to do is to get them smooth, regular, and of proper outline at first, by getting proper drawings and having proper patterns; by taking care in lapping the patterns when making the mold, and by being careful to use the proper metal and to pour it rightly. Then the tooth curves will be such as to insure regular action, and the surfaces will be such as to run smoothly; while the skin of the castings, which is the best part of them, will not be taken off before the wheels are put to work.

A better way than to make patterns of large wheels is to make a good templet and make the mold by a gear molding machine, with a good index plate and stiff radius bar.

* * *

I see that you are using wooden core boxes for those round cores; and if you will take the trouble of inspecting and calipering those which have been made for awhile you will find most of them out of round very perceptibly; the wood having shrunk unequally. Where a core box for round cores is to be used several times at wide intervals, it should be of cast iron, which has the habit of keeping its shape.

Another thing that I notice in your foundry is that some of the men do not wet their core irons with clay water or clay cream before putting them into the sand. The sand will not cling to them well without. And in the large cores you are using wrought iron core irons, which cost much more than cast iron ones and are not quite so good, not having so many roughnesses for the sand or the clay wash to stick to. You will find, too that you can use ashes for the center of those large cores, serving the purpose of vent wires.

* * *

The trouble with those cores is th at they are "baggy" from being heated too hot in the core oven; and they are slack on the

core bar through contraction of the core and expansion of the core iron taking place at the same time. Those are large cores, and instead of heating them so high to dry them they should have been put in the stove after each couple of courses of straw and loam. Made that way they will take more time but you will have fewer spoiled cores and spoiled castings and it will pay better in the end.

* * *

The trouble with your lathe is that it has been doing right-handed work for years and years, cutting right-handed threads and as the wear has taken place on only one side of the lead screw its pitch has been increased since you first got it. Further, it has been used most at the end nearest the live center, and is most worn there; and as the wear increases the screw will have not only too great a pitch, all along that part of the screw which has been used, but an irregular excess which cannot be calculated for or allowed for. If it was arranged so that you could turn it end for end every now and then you would at least have the error caused by and upon short work lessened and divided between the two ends; but for all that the pitch would not be true. The next time you get a lathe of such a construction, if you do ever get one just like it, better do your general screw cutting on one end and for special work requiring to be very correct use the other end. Then if you want you can keep the wear from coming on only one side of the screw, not by cutting left-handed screws, but putting a pulley at the tail of the lathe and by a cord attached to the carriage at one end and a weight at the other making the carriage drag the screw instead of the screw pushing the carriage. This will put some of the wear on the left side of the threads instead of the right, even in cutting right-hand threads. You may say that every time the carriage is brought back there is a pressure put upon the other side of the screw threads, but in reply to this I may say that on the back travel there is no pressure as during the cut.

* * *

You will find that the work of getting up ordinary sketches of machines and other work will be very much facilitated by having pads of paper faint-ruled in such squares, subdivided into 1-8 or 1-10 inch squares. In repair work many a job can be indicated better in this way than by a finished drawing; and in altering machines also, where the full lines of the original drawing would be useless as indicating processes and measurements that are through with, the mere sketch outlines, upon paper ruled to 1-8 inch or 1-10 inch squares, would appeal at once to the eye of the workman and not confuse him with a mass of detail upon which some other workman had been engaged years ago, and upon which no other workman will ever be engaged again while it exists.

* * *

You don't seem to have quite struck the way to get these connecting rods true in the way of alignment of side faces and edges. Get a straight edge longer than the entire rod; apply it to one of the cheeks of the big end and note the distance between it and the cheek of the small end. Do the same thing with the other side; then you will see whether or not the alignment is right. If the distances are unequal, one of the stub ends is to one side of the center of the rod. Then apply the straight edge to the wide face of the small end and let it lie on the narrow edge of the large end, scribing a line to show the amount by which the large end projects each side, beyond the small one. Do the same thing with the other side. The two distances of offset should be equal. Then take two "winding strips" and lay them parallel, one on each wide face on one side of the rod; sight them, and if they do not come in the same plane the faces are out of plane with each other.

* * *

In pinning that crank hub on to that shaft by a pin passing through a diameter of the hub you are not taking advantage of the full strength that you could get out of the same pin. Suppose that instead of the pin passing through a diameter as you have it, it was to go through the shaft at a point very near its circumference, forming

a chord instead of a diameter. In that case it will present more material to be sheared off than where it runs straight through. Where it goes through the diameter the amount of material to be sheared off in order to permit the hub being moved on the shaft, is simply twice the sectional area of the key; but where it forms a chord, that amount may be more than trebled.

* * *

Instead of blueing those steel pieces by heat in order to permit the lines marked on them to be plainly seen, it would be much better if you would copper the surface by rubbing it with a saturated solution of sulphate of copper (blue vitriol; bluestone) which will coat the surface with a very thin film of pure copper. If the surface is greasy, or unfinished, a few drops of sulphuric acid to the ounce of solution will make it work all right.

* * *

You seem to be laboring under a bad case of imperfect chill over there in the foundry. If you will try using a little spiegeleisen you will find that you will get more chill than you now have; and if what you try does not give enough, you can try until you get what you want. I have seen chills eight inches deep at Gruson's foundry, in Buckau near Magdeburg, run off as an every-day occurrence. What they can do there you can do here. You may not want to get eight inches of chill, as you may not be casting sections for cast-iron forts as they were, but you can get just as much or as little chill as you want—always bearing in mind that the mere fact of pouring metal in a chilling mold does not necessarily give a chilled casting. Otherwise you could chill lead or anything you wanted, as hard as car-wheel treads or lathe tools.

* * *

About the most difficult inventors to understand are those who insist on showing all four sides of their invention on one single drawing. Three are bad enough, and I found a concern in Philadelphia that wanted to show the front and both sides of a large office building in one view. But I came across a Western firm that shows both the front and the back of their machines by one photograph. They manage it by placing a mirror back of the machine and having the camera at such a height as to show the rear view directly over the front one. It is a good trick for certain classes of machinery.

* * *

The great drawback to the use of a condensing engine is scarcity of water. Of course if you have but little water you cannot under ordinary circumstances do much good with a condenser; and the trouble is that engines are generally used where there is little water, at least falling under a head. But suppose that for some reason or other you have your engine running condensing and the supply of condensing water goes out—you need not be cast down, so long as you have a roof over your head. A sheet of hot water allowed to fall over a roof will get considerably cooled in its passage; and if caught may be used over and over again. In any case it is cooler than if it is not made to flow over the roof.

* * *

You want to find out whether the live center and the tail center of that lathe are in perfect alignment now that that piece is chucked. Well, if you will take a piece of iron that will reach from the tail center to some point on the outer part of the object that is chucked, and will make a cone center in one end of it and put that on the tail center and let the other end touch the face of the object at some point, scribing that point, and will then turn the lathe 90° and see whether the end of the gage piece strikes it at the same distance from the live center, and will then turn through the other quarters in the same way, you can find out what you want to know. If the radial distance is the same in all cases the centres are all right; but if the gage reaches further out at one quarter position than at the other, they are not, and you will have to make them so before you go on with the work.

* * *

I had it impressed on me at a very early stage of my existence that there are more ways of killing a cat than by choking it to death with butter; and I have tried to ap-

ply that fact through life and to impress it on others. You have a big fly wheel that you cannot very well turn off as well as you want. It seems to be well enough balanced—as well as any standing balance can be made—and all that you want now is to give it some sort of a finish for the main belt to run on. Well, don't send it out to be done on the big turning and boring mill down the street, but just wait until it is on the main shaft and the engine is started up slowly, and then turn it in place by a piece of grindstone held as a tool. For that place, that job and that class of an engine it is well enough; and you can do a piece of work that will be as good as many turned out by establishments that are quite well equipped, and which seem to want to get by stone finish a reputation that they never could get by decent design and construction.

* * *

You want to get screws with a metric pitch, for that Persian job, and don't know just how to make your lathe walk Spanish? Few things easier. Make a translating gear having on one stud two wheels, one with 50 teeth and the other with 157. Their ratio is 1 to 0.3937 and that is about as close as you will be liable to get anything; for the lathes that work to fine decimal points are few and the men who will do it on them just as few.

* * *

About the best way to get a working drawing of a complicated piece where the outline is very complicated or the exact shape of the curve is an important factor, is to make a blue print from the original sample itself. The watch-makers and makers of watch-making machinery do this with great success and satisfaction.

* * *

Your man is complaining that his file "pins" or fills with copper filings when he is filing down those commutators. There are two ways by which he can prevent it; one to use the file backwards for the finishing touches and the other to chalk the tool well every now and then; the chalk will prevent the filings from sticking to the steel. Another way still is not to file the commutators, but to work them down with sandpaper—not on any account with emery cloth, because that will fill the places between the sections with a conducting film of oxid of iron. If you will take a block, work in it a semi-circle of the same diameter as the commutator, and line this semi-circle with glass cloth you can by turning the commutator at a high speed and applying the glass-cloth-covered block bring the commutator to as high a degree of finish as you desire.

* * *

Instead of packing up those pieces with blocks of this size, and that size and the other size, and with thick and thin pieces of this, that and the other stuff, why not make yourself some short jack-screws consisting of a disk or flat-footed piece having in the center an upright bored out and threaded on the inside, and in which is a stout screw with a big head. Such a rig as that will enable you to set pieces at any desired height and always to get the same height; also to get both ends of sides of the same piece at the same height. If you have a lug cast on one side of the post and split the lug and the post you can use a pinching screw to prevent any possible loss of adjustment.

* * *

For boring long deep holes that do not go clear through the pieces so as to permit of using a boring bar, use a tool having right back of it a set screw which may be run out so as to touch the opposite side of the bore from the one the tool is working on; and have half way between these two so as to touch the circumference of the bore hole 90° from the tool and 90° from the first screw, a similar screw which may be adjusted so that the tool will be kept centrally and the hole kept straight. If the job be such as to permit the hole being bored vertically, there will be no trouble about getting out the borings or having them crowd under either of the set screws; but if it must be a horizontal job, the tool must be rigged so that one of the screws shall be at the top, and the other at one side, the tool being on the other side.

* * *

I saw a rather neat way of making lead-pipe joints the other day. There was a

female die made, of conical shape, and this was forced over the end of each pipe and hammered so as to make a cone on each of the two ends that would be jointed together. Then they were inserted one after the other in a double taper collar which was threaded inside, and expanded by a mandrel until they took the form of the threads and were left with cylindrical bore of the original side of the pipe. There is no question about the perfection of the fit between metal and metal in such a job as that.

* * *

A good alignment gage for a lathe may be made by taking an iron bar half as long as the diameter of the face plate, and having at one end an enlargement in its width, in which there is a small cylindrical hole bored through and then countersunk from both sides, not letting the two countersinks meet. If this is put to the centers so that one projects into each countersink without their points meeting, the bar will stand at a certain distance from the face plate; this distance being measured, and the bar turned about so as to make first 90° then 180° and then 270° from the first position, the distance of its face from that of the plate should be the same in all four positions. If they are not, the lathe is out of line; and if they are, it is all right in that respect.

* * *

Where one man has to attend several tools or to attend one tool and do something else while waiting for it to get through its cut, it is well to have an electric annunciator to give an audible signal just before the cut is through. This may be done by having a brass rod pressed by a spring against the moving piece or against the carriage, and so placed that when at a convenient distance from the end of the stroke or cut, it shall enter between two spring clips of sheet brass which are connected to an electric battery and bell, so that on the circuit being completed the bell shall be started ringing.

* * *

One reason why so many planer belts do not last long is that their edges are spoiled by the constant action of the shifting; and the same may be said of many other belts which are shifted by the ordinary pole or by even a regular shifter. To lessen the wear and tear and prolong the life of the belt, make the shifter to bear against the edges of the belt by grooved rollers or wheels instead of by a bare edge; the wheels will rotate and be easy on the belt edges.

* * *

If you want these pieces duplicated every now and then, don't send drawings down to the shops; send the things themselves. The men's calipers will tell them what dimensions to give; there can be no mistake about what metal or other material is to be used, nor as to the number of each kind of piece to be made; and better yet, there will be uniformity of finish for each part and place.

* * *

I have recently heard a story which reminds me very much of the conditions of affairs at Ridley's shop. A little girl, very much excited, ran into the parlor, which was full of company, and exclaimed: "Mamma, just think of it!" "Think of what, darling?" "Our cat has a whole lot of twins, and I didn't even know she was married!" Ridley is very much excited over a new machine for boring square holes with a rotating tool, when as a matter of fact he has been doing the same thing for years on about every seventh job that has come into the shop. There isn't a drill press in his place that is not full of lost motion; and the result is that the spindles wabble at a great rate, and never make a round hole unless luck is dead in his favor. Now the square hole machine is only a development of the wabbling drill press idea. He has been brought up to the idea that square holes cannot be drilled by a rotating tool, and that something in the way of a drift, or of a slotting tool, is required to make square holes; and here he has been making them, in a way, ever since his drill press commenced to get out of truth, and that is over 25 years to my knowledge, for it is over that length of time since I first used to peep in and wonder how mechanics could work in the dark.

COMMENT & CRITICISM.

I WAS very much interested in the article written by Mr. Leicester Allen on "Ventilation of Homes and Schools," printed in the September number of this magazine. It seemed in line with a study I have been pursuing for four or five years. About six years ago I became interested in the matter of heating and ventilating school-houses, but could find no method that seemed competent. In seeking to devise a method, I became convinced that the proper way was to introduce the fresh, warm air in numerous small jets, but I could not ascertain the existence of any apparatus for doing this in a practicable manner. I then designed a system of distributing-pipes leading to the chairs, and also a base for a chair, that enables the air to be distributed to each scholar, the foul air to be removed by a system of drop-flues. Thus each scholar would receive his quota of fresh air and not breathe air that had once been breathed without a subsequent and adequate intermixture of pure air.

My means are limited, and I therefore have only been able to experiment on a limited scale; but I was convinced my theory was correct before reading Mr. Allen's article, though I have had my ideas laughed at as ridiculous because so radically different from those commonly entertained; but the article has emboldened me to thus publicly state the above facts in the hope that some one interested in ventilation and having means to assist me in carrying out my invention on a proper scale, may be induced to investigate it; and I think it would make an interesting exhibit at the coming World's Fair at Chicago.

JAMES T. JOHNSON.

North Andover, Mass.

Public-Land Surveying.

WHERE is there a State or Territory in the Union that can point with pride to its "public-land surveying"? Any engineer who has made a survey—preliminary or location—for a railroad, remembers the annoyance and delay in trying to find section-lines or corners to "tie" to, and the maledictions hurled at the head of the United States deputy surveyor, who did the work, have been something terrible.

For such a state of affairs, the Government is entirely to blame—first, because the work is done by contract (?); second, because nearly every Surveyor-General is totally unfit for the position. The office is looked on as one of the "political plums," and lawyers, farmers or merchants are appointed, but very seldom an engineer. I have seen a great many methods pursued by United States deputy surveyors, and have yet to see the first one who does his work according to the requirements of law; but they write their notes as if the work was legally done.

In one of the counties in South Dakota the surveyor who had the contract started six men—each with a shovel—one mile apart on the East boundary of the township. They were to step off half a mile, for the quarter corner, one mile for the section corner, etc. This they did across the township. They had no instrument, and if one of them thought he was getting too close to his neighbor, he would bear North or South until he "guessed" he was at the proper distance. In other parts of the State I have found section-lines that would over-run as much as 400 feet in a mile, and some would be the reverse. I think that I can say, without successful contradiction, that there are few townships surveyed correctly, in any State where the work was done by contract.

The Surveyor-General lets the contracts (that is he gives the work—no bidding is asked for or received—the Government has a fixed price, per mile, for prairie, timber, mountain and meandering). This is usually given to some "political" friend, whether he is a surveyor or not. No contract can be sublet, the department requiring a contractor to do his own work. The law re-

quires the contractor to be a practical surveyor; but this is gotten around by the contractor employing some person who can look through an instrument and read the needle, who calls himself a surveyor. The contract is made out in their joint names, although the surveyor (?) only gets a small salary, usually from $50 to $75 per month.

The Surveyor-General also appoints the inspectors of surveys, who make their report to him, and he forwards the inspection, notes of survey and plats to the Commissioner of the General Land Office, Washington. The inspectors should be sent direct from the General Land Office and send the inspection to the Commissioner without passing through the Surveyor-General's office.

It is said "There is no evil that cannot be corrected." In this case it is true, for if the Government would do away with the contract (?) system and employ thoroughly practical and competent engineers, at a salary, to do the work, the result would be good work and a saving in expense.

The time of a civil engineer is too much taken up with matters pertaining to his profession to meddle with politics. They have no "lobbyists" at Washington, and no one interests himself enough to see to the passage of laws barring incompetent and unreliable men from the profession. The result is, there are many ignorant and untrustworthy men, who carry a chain for a season or two and learn to read the vernier, then call themselves "civil engineers." This class are willing to work for a mere pittance, and because they are cheap (?) they do frequently succeed in getting work. Their work reflects on the whole profession.

Engineers are greatly to blame for giving letters of recommendation indiscriminately. Because a man is a good chainman or can use a transit or level on a survey, is no reason to say he is a "thoroughly competent engineer." On two or three occasions I have employed assistants who had excellent testimonials as to proficiency, and have been woefully disappointed.

Once I asked a noted engineer why he had given Mr. Blank testimonials as to ability? His reply was, "Oh! he's a good fellow; he asked me for a letter, and I did not like to hurt his feelings by refusing." We all hate to hurt the feelings of a fellow-being; but it is not justice to the man, to the profession or to ourselves, to recommend a man we know to be incompetent.

J. C. BARTON, C. E.

Chamberlain, S. Dak.

Americans Not Ahead in Everything.

IN reading the very interesting articles by Dr. Coleman Sellers in THE ENGINEERING MAGAZINE we must not forget that there are certain lines in which we are still behind the other nations of the world in applied mechanics. For instance, in the line of jute machinery the English are far ahead of us; in hydraulic machinery, as for bending crank-shafts, and making hollow screw shafts, for steamships, we are still further behind them than in textile lines; and when it comes to locomobiles, or friction engines, or whatever they may be called, the mother country still leads us most disgustingly. I think it hardly fair, too, that we should take the credit, as Americans, for the brains of Benjamin Thompson, a Yankee who was given the rank and title of Count Rumford in a foreign service, and at the same time appropriate to ourselves the fame of the Swedish Ericsson. If we are entitled to credit for Thompson, we must drop Ericsson; and if we consider Ericsson to belong to the country of his adoption, we must give up the Massachusetts-born Count.

AMERICANUS.

Government Engineering.

WITH reference to this topic, as discussed in your January number by Mr. Wisner, permit me to say that I think some engineers not in the service have acquired a bad impression of Government engineers through carrying into their intercourse with the latter a certain unpleasant manner of superiority arising from a petty jealousy. Whatever the faults of Government engineers may be, they are usually gentlemen, and, I doubt not, some well-deserved snubs, administered as rebukes to discourteous manners, have led to some bitter feeling not warranted on the ground of merit.

C. E.

EDITOR'S EXCHANGE TABLE.

AN INDEX TO CURRENT TECHNICAL LITERATURE.

THE tabulated list contains the names of exchanges most frequently quoted. To save space the abbreviations respectively prefixed are employed in the list of articles following the index. Illustrated articles are indicated by an asterisk (*), continued articles by a dagger (†), and concluded articles by a double dagger (‡). Orders for copies of publications mentioned should be sent direct to the addresses given.

A A.....American Architect. *w.* 15c. Boston.
A E .....Architectural Era. *m.* 25c. New York.
A & B....Architecture and Building. *w.* 15c. New York.
A J R A..American Journal of Railway Appliances. *m.* 25c. New York.
A M.....American Machinist. *w.* 6c. New York.
B J C....Boston Journal of Commerce. *w.* 6c. Boston.
C A B ....Canadian Architect and Builder. *m.* 20c. Montreal.
C E .....Colliery Engineer. *m.* $2 per year. Scranton, Pa.
E E L ....Electrical Engineer. *w.* 3d. London.
E E N Y..Electrical Engineer. *w.* 10c. New York.
E L.....Electricity. *w.* 1d. London, Eng.
El.. .....Electrician. *w.* 4d. London, Eng.
E C .....Electricity. *w.* 7c. New York-Chicago.
E R L.....Electrical Review. *w.* 4d. London, Eng.
E R N Y...Electrical Review. *w.* 10c. New York.
E W.. ....Electrical World. *w.* $3 per year. New York.
E.....Engineering. *w.* 6d. London, Eng.
E M J.....Engineering and Mining Journal. *w.* 10c. New York.
E N.....Engineering News. *w.* 15c. New York.
I E.....Indian Engineering. *w.* As. 8. Calcutta.
I L. .....Industries. *w.* 6d. London, Eng.
I A.. .....Iron Age. *w.* 10c. New York.
I J M S...International Journal of Microscopy and Natural Science. *m.* 6d. London-New York.
Inv.....Invention. *w.* 6d. London, Eng.
J A E S...Journal of the Association of Engineering Societies. *m.* 30c. Chicago.
J O I.....Journal of Industry. *m.* 20c. San Francisco, Cal.
J F I .....Journal of the Franklin Institute. *m.* 50c. Philadelphia.
J N E W..Journal of the New England Waterworks Association. Quarterly. 75c. New London, Conn.
J S A.....Journal of the Society of Arts. *w.* 6d. London, Eng.
L E.....Locomotive Engineer. *m.* $1 per year. New York.
P A.....Progressive Age. *w.* $3 per year. New York.
P S.....Power-Steam. *m.* $1 per year. New York-Chicago.
P T.. ....Photographic Times. *w.* 15c. New York.
N .....Nature. *w.* 6d. London.
N B .....National Builder. *m.* 30c. New York-Chicago-St. Louis.
S A S.....Scientific American Supplement. *w.* 10c. New York.
Sc.....Science. *w.* 10c. New York.
S... .....Stone. *m.* 15c. Indianapolis, Ind.
R A E J..Railroad and Engineering Journal. *m.* 25c. New York.
R A.....Railway Age. *w.* 10c. Chicago.
R G.....Railroad Gazette. *w.* $4.20 per year. New York.
R M M... Railway Master Mechanic. *m.* $1. Chicago
R R.....Railway Review. *w.* 10c. New York.
W E.....Western Electrician. *w.* 10c. Chicago

ARCHITECTURE.

American Homes. Mrs. S. Van Rensselaer (The Forum *m.* 50c. New York–Jan.)

Architecture of the West.* H. Van Brunt (Kansas City Architect and Builder *m.* 15c–Dec.)

Decorative Treatment and Materials. G. Howe (Ibid.)

Climatic Influences upon Architecture. G. F. Stalker (C A B–Dec.)

How to Estimate.* W. H. Hodgson (C A B–Nov.)

Architectural Training. A. C. Hutchinson (Ibid.)

Steel Skeleton Type of High Buildings.* † (E N–Dec 26.)

American Theaters.* (A A–Jan 9.)

Sculpture and Sculptors' methods in Relation to Architecture.* † J. Belcher (A & B–Jan 9.)

Building Inspection (C A B–Jan.)

Hydraulic Cements (Ibid.)

Transition of the American Dwelling-House (A E–Jan.)

CHEMISTRY.

A New Principle in Industrial Chemistry (I L–Dec 18.)

Electrolysis of Gold Salts. A. Watt (E E L–Jan. 1.)

The Progress of Chemistry in 1891 (I L–Jan 8.)

The Application of Chemical Energy to useful Work (Mechanical World *w.* two pence London–Jan 8.)

CIVIL ENGINEERING.

Proposed Lake Erie and Ohio Canal. J. M. Goodwin (Transactions Am. Soc. C. E. New York–Oct.)

Government Improvement on the Pacific Coast. B. W. De Couvey (Ibid.)

Hudson River Bridge* (A M–Dec 31.)

Deep Water and National Development. (Age of Steel *w.* $3 per year. St. Louis–Jan. 2.)

The Proposed Tunnel Under Boston Common. (Street Railway Gazette *m.* 25c. Chicago–Dec.)

Proposed Improvements to The Port of Penang. Sir John Coode* (I E–Nov 28.)

The York Tunnel of the Baltimore Belt Railroad.* W. P. Paeet (E N–Jan 9.)

A Short History of Bridge Building. C. R. Manners* (E–Jan 1.)

Vitrified Brick, the Roadway of the Future. E. Stabler, Jr. (Paving and Municipal Engineering *m.* 10c. Indianapolis–Jan.)

An Engineer's Advice Regarding City Improvements. (Ibid.)

Civil Engineering in 1891 (I L–Jan 8.)

The Gospel of Good Roads. I. B. Potter (Good Roads *m.* 20c. New York–Jan.)

ELECTRICITY.

Recent Progress in Magnetism. B. S. Giles (S A S–Dec 26.)

Electric Reciprocating Engine. C. J. Van Depoele (I A–Dec 24.)

Light Plant in the "Fair" Building, Chicago* (W E–Dec. 26.)

Polyphasal Generators. M. I. Pupin (W E–Dec 26.)

Electrical Progress of 1891 (E W–Dec 26.)

Compensating Resistances for Galvano Meter Shunts.* C. P. Frey (E E N Y–Dec 23.)

E. M. F. with special reference to Ohm's Law.† Maurice Oudin (Ibid.)

Practical Formulæ for Street Car Motors. T. Reid (Ibid.)

Electricity in the Theater* (E C–Dec 23.)

Dental Electrics.* C. E. Kells, Jr. (Ibid.)

Electrical R. R. Construction and Operation. C. J. Field (Canadian Magazine of Science *m.* $2.50 per year. Montreal–Nov.)

Notes on Electric Street Railway Construction.* A. K. McCay (E E N Y–Jan 6.)

Frauds in the Electrical Business. A. A. Knudson (E E N Y–Jan 6.)

Electric Drilling in the Bed of the Mississippi* (W E–Jan 9.)

Niagara the Motor for the World's Fair. Prof. J. Trowbridge (Ibid.)

Measurement of the Resistance of Conductors.* R. Appleyard (Ibid.)

The Education of an English Engineer (E L–Dec 18.)

Specifications for a Low Tension System (E E E–Dec 18.)

The Principles of Alternate Current Measurement. H. E. Harrison (E L–Dec 18.)

Electricity at the Plow. A. A. Denton (E E N Y–Dec 30.)

Electric Lighting in New York* (E W–Jan 2.)

Magnetic Leakage in Dynamos and Motors* (E W–Jan 2.)

Telegraph Systems. F. Jarvis Patten* † (E C–Dec 30.)

Central Stations at Home and Abroad.* † J. Maier and A. P. Haslam (E L–Jan 1.)

Wiring for Motor Circuits. T. J. Grier (Electrical Industries *m.* 30c. Chicago–Jan.)

Practical Instruments for the Measurement of Electricity. J. T. Nibblett and J. T. Ewen (E E L–Jan 1.)

The Wiring of Houses for Electric Lighting. Ed. C. De Segundo (E R L–Jan 1.)

Deductions from Mr. Speyers' Researches on the Electro-Motive Force of Metallic Salts (Ibid.)

America's Part in the Discovery of Magneto Electricity.* † Mary C. Henry (E E N Y–Jan 13.)

Experience of Cities with the Trolley System. S. W. Balch (Ibid.)

Long Distance Transmission of Power by Electricity. F. R. Hart (Ibid.)

Pictorial Telegraphy.* A. P. Trotter (E W–Jan 16.)

Electrical Exhibits at the Columbia Exposition. J. P. Barrett (W E–Jan 16.)

A Lead Galvanizing Process* (Electrical Plant *m.* 6 pence. London–Jan 1.)

Improvements in Telephone Apparatus (E C–Jan 20.)

Electrical Transmission of Power. Earl of Albermarle (The Nineteenth Century *m.* 40c. New York–Jan.)

Berliner "Electrodes." J. A. Barrett (E E N Y–Jan 20.)

Combined Accumulator and Gas Battery. F. A. Lu Roche (Ibid.)

Electric Block Signalling on the New York Central (E W–Jan 23.)

Electric Lighting of the French Battle-Ship *Marceau.* H. Hutchins (Ibid.)

New Electric Railways for London (E L–Jan 8.)

The Progress of Electrical Engineering during 1891 (I L–Jan 8.)

Caustic Soda and Chlorine Electrolytic Process (El–Jan 8.)

Important Litigation on Insurance of Central Stations (E R N Y–Jan 23.)

Crystal Palace Electrical Exhibition (E–Jan 8.)

HYDRAULICS.

Irrigation Progress in the Arid West (E M J–Jan 2.)

The Aqueduct Tunnel under the Mersey (E–Jan 1.)

Appliances for Pumping on Modern Steamships (Engineers' Gazette *m.* 3 pence. London–Jan.)

Water Power in London (Invention *w.* 6 pence. London–Jan 2.)

Steam Pumps. J. C. Smith (Scientific Machinist *s. m.* 7c. Cleveland–Jan 15.)

GEOLOGY.

The Relation of Geological Survey to successful mining. A. Winslow (Sc–Dec 25.)

MARINE ENGINEERING.

Screw Steamship and Tow Barge efficiency on American Lakes. J. N. Oldham (Transactions Am. Soc. C. E. New York–Oct.)

The Atlantic Liner, Past, Present and Future* (E–Dec 4.)

Engines for Ships of War (I C–Dec 25.)

Ship Building and Marine Engineering during 1891 (I L–Jan 8.)

MECHANICAL ENGINEERING.

Dry Sand Molding.* S. Boland (A M–Dec 24.)

Variable Pitch.* F. R. Hovey (Ibid.)

Riveted Joints* (E–Dec 4.)

Compound Air Compressors and Motors (Ibid.)

Mining Tools and Appliances. R. R. Lister (E–Jan 1.)

Standard Measurements in Machine Construction.*† F. J. Miller (A M–Jan 21.)

Cores for Dry Sand Molding. S. Bolland (Ibid.)

Engineering Progress in 1891 (I L–Jan 8.)

METALLURGY.

The Physics of Steel. W. Metcalf (E–Jan 8.)

The Metal of the Future (R A–Jan 15.)

MILITARY ENGINEERING.

Canet *v* Krupp Guns (E L–Dec 25.)

The Trial of American-Made Armor-Plate. Lieut. J. M. Califf (R A E J–Jan.)

MINING.

New Mexican Mining.*† T. F. Van Wagenen (Financial and Mining Record *w.* 10c. New York–Dec 26.)

The Gross Output of Colorado Mines (Mining Industry *w.* 10c. Denver–Dec 31.)

Electricity in Gold Mining* (W E–Jan 2.)

The Operation of the U. S. Mining Law. Dr. R. W. Raymond (E M J–Jan 2.)

Mineral Statistics for 1891 (E M J–Jan 2.)

Uniformity in Assay Methods (The Mining Industry and Tradesman *w.* 10c. Denver–Jan 7.)

Tunneling in Soft Ground (E N–Jan 16.)

PHOTOGRAPHY.

Reversal (P T–Dec 25.)

The Latest Improvements in Photo-Micrography* (E N–Jan 2.)

Gelatine Ferrotypes (P T–Jan 8.)

Reducing Agents Capable of Developing the Photographic Latent Image (Ibid.)

The Chemistry of Photography† (P T–Jan 15.)

Para-Amidophenal (British Journal of Photography.)

RAILROADING.

The American Railroad Viaduct. Its Origin and Evolution. J. E. Grenier (Transactions Am. Soc. C. E. *m.* $10 a year. New York–Oct.)

A Decade of Street Railway Development (R R–Dec 26.)

Government Ownership of Railways (Ibid.)

The Liverpool Overhead Railway †* (E L–Dec 18.)

Erecting a Locomotive* (E L–Dec 18.)

Running a Railroad. J. Alexander (L E–Jan.)

Rapid Transit in Great Cities. St. John V. Day (E W–Jan 2.)

The Transandine Railway* (R A–Dec 11.)

Swing Beam Versus Rigid Trucks. Horace A. Towne (R A–Dec 11.)

The Common Use of Box Cars. S. H. Church (R G–Dec 25.)

Cheap Railroad Service in India (Ibid.)

Train Accidents in the United States in November. (R G–Jan 1.)

The Application of Electricity to Block Signaling. (E W–Jan 9.)

The Street Railway Situation in Chicago. (Street Railway Journal *m.* 35c. New York–Jan.)

The Kansas Railroad Commission. Albert R. Greene (The Cosmopolitan *m.* 25c. New York–Jan.)

American and English Railway Traffic (E–Jan 1.)

Fifth Annual Report of the Inter-State Commission (R R–Jan 9.)

Railroad Insurance (Ibid.)

Automatic Block Signalling (E W–Jan 16.)

Railway Dividends Versus Human Lives (E C–Jan 13.)

Notes on the Application of Switching by Gravity at the Station Les Aubrais, translated from the Revue Generale des Chemins de Fer. (R R–Jan 9.)

Railway Statistics of the United States (R R–Jan 16.)

Locomotive Testing (Ibid.)

Official Street Railway Statistics (Street Railway Review *m.* 15c. Chicago–Jan.)

The Evolution of the Street Car* (Ibid.)

Speed of Electric Tramways (E–Jan 8.)

SANITARY ENGINEERING.

Single Trap System of House Drainage. L. Anderson (Transactions Am. Soc. C. E. New York–Oct.)

Disposal of Town Refuse.* W. C. Foster (E L–Dec 18.)

Main Relief Sewer, Brooklyn, N. Y.* (E N–Jan 2.)

Village Sewage (A & B–Jan 9.)

STEAM ENGINEERING.

The Strength of Cylindrical Boilers.* G. R. Bodmer (I L–Dec 18.)

Belts and Belting * (Journal of Commerce *w.* 6c. Boston–Dec 26.)

Centrifugal Pumps: Their Use on Warships. Alfred Burner (Mechanical World *w.* one penny London–Dec 25.)

Notes from an Engineering Laboratory (E L–Dec 25.)

How Engines are Tested. Thomas Hawley (Boston Journal of Commerce *w.* 6c.–Jan 9.)

The Common Slide Valve and Gear Practically Considered † * (Engineers' Gazette *m.* 3 pence. London–Jan.)

The Steam Loop. W. C. Kerr (Street Railway Review *m.* 15c. Chicago–Jan.)

The Development of the Steam Engine for Mill Driving (Mechanical World *m.* 2 pence London–Jan 8.)

The Parsons Steam Turbine Dynamo (El–Jan 8.)

The Danger of Circulating Boilers (E–Jan 8.)

MISCELLANEOUS.

The Japanese Earthquake: W. H. Harrington (Sc–Dec 25.)

Has Crime Increased in Massachusetts? W. F. Spaulding (The Forum *m.* 50c. New York–Jan.)

Why the Silver Law Should be Repealed. G. S. Coe (Ibid.)

Sales Department Slips.* W. H. Pardee (Business *m.* 10c. New York–Dec.)

Typological Museums. Pitts Rivers (J S A–Dec 18.)

Attacks Upon Public Parks (The Century *m.* 35c. New York–Jan.)

Aluminum—The Metal of the Future.* Joseph W. Richards (The Cosmopolitan *m.* 25c. New York–Jan.)

Rain and Other Mysteries. A. Ewbank (I E–Nov 28.)

The History of Brick Manufactures. S. K. Fletcher (Paving and Municipal Engineering *m.* 10c. Indianapolis–Jan.)

Industries and Commerce during 1891 (I L–Jan 1.)

Economic Distribution of Earnings *vs.* Profit-Sharing (Social Economist *m.* 20c. New York–Jan.)

The English Gang System (Ibid.)

Taxes on Transport. W. M. Ackworth (The Nineteenth Century *m.* 40c. London–Jan.)

A Curious Case of Damage by Lightning (E R L–Jan 8.)

The Commerce of San Francisco. G. W. Dickie (Industry *m.* 25c. San Francisco–Jan.)

Electricity in Agriculture (Sc–Jan 15.)

SOME RECENT BOOKS.

Allsop, Robert Dale.—The Hydropathic Establishment and its baths. By the author of "The Turkish Bath: its design and construction." Illustrated. New York: E. & F. N. Spon & Co. [8vo, cloth, p. 107, plans, $2.]

American System of Block Signalling, with descriptions and drawings of the different systems in use on railways in the United States. Illustrated. New York: *Railroad Gazette.* [8vo, cloth, $2.]

Carpenter, R. C.=Manual of Engineering Laboratory Practice. Consisting of an abstract of lectures * * * in the Mechanical Laboratory, Sibley College, Cornell University, with special directions for testing, etc. Ithaca, N.Y.: Andrus J. Church. [8vo, cloth, $4.50.]

Carpenter, William B.—The Microscope and its Revelations. Philadelphia: P. Blakiston, Son & Co. [8vo, cloth, p. 1050, $6.50.]

Dingey, P. S. —Machinery Pattern Making,

containing Full-Sized Profiles of Gear Teeth and Engravings on Full-Page Plates, Illustrating Manner of Constructing Numerous and Important Patterns and Core Boxes. New York: John Wiley & Sons. [12mo, cloth, p. 89, 375 illustrations, $2.]

Donaldson, James (editor).—The *Engineers Gazette* Annual and Almanac for 1892. London: Power Publishing Co. [12mo, paper, p. 188, 1 shilling]

Eardley-Wilmot, Capt. S.=The Development of Navies during the last Half-Century. New York: Charles Scribner's Sons. [Cloth, $1.75.]

Eissler, M.=The Metallurgy of Argentiferous Lead. A Practical Treatise on the Smelting of Silver-Lead Ores and the Refining of Lead Bullion. Including * * * descriptions of Modern Furnaces and Plants in Europe and America. London: Crosby, Lockwood & Co. [12mo, cloth, 183 illustrations, $5.]

Emmens, Stephen H.—Explosives and Ordnance Material, considered with reference to some recent experiments with emmensite, gelbite and aluminum bronze. Illustrated. Baltimore: The Author. [P. 93.]

Ferguson, F. O.=Architectural Perspective; the whole course and operations of the draughtsman in drawing a large house in linear perspective. Illustrated. London: Crosby, Lockwood & Co. [8vo, cloth, $1.40.]

Findlay, George.—The Working and Management of an English Railway. Fourth edition, revised and enlarged. New York: Macmillan & Co. [Cloth, 12mo, plates, $1.50.]

Foster, Horatio A.—Central Station Management and Finance. New York: C. C. Shelley. [12mo, p. 50, $1.]

Gibbins, H. De B.—History of Commerce in Europe. New York and London: Macmillan & Co. [12mo, cloth, p. 233, with maps.]

Gieseler, E. A.=The Range of Tide in Rivers and Estuaries with especial reference to the influence exercised on it by works of improvement. Philadelphia: The Author. [8vo, pamphlet, 50 cents.]

Gould, A. C.=Modern American Rifles. Illustrated. Boston: B. Whidden. [8vo, cloth, $2.]

Hobson, E. W.=A Treatise on Plane Trigonometry. Cambridge: Macmillan & Co. [8vo, cloth, $3.]

Hood, Charles, *F. R. S., F. R. A. S.*—A Practical Treatise upon Warming Buildings by Hot Water, and upon heat and heating appliances in general, with an inquiry respecting ventilation, the cause and action of draughts in chimneys or flues, and the laws relating to combustion. Re-written by Frederick Dye, author of "Hot-Water Supply," etc. New York: E. & F. N. Spon & Co. [8vo, cloth, p. 512, $6.]

Hughes, W. G. C.=Condensed Mechanics; a selection of formulæ, rules, tables and data for the use of engineering students, science classes, etc. London: Crosby, Lockwood & Co. [12 mo, cloth, $1.40.]

Kirk, Arthur.=The Quarryman and Contractors' Guide, or How to Remove Rock at Least Cost, including articles on the Importance of Blasting Explosives, etc. Illustrated. Pittsburgh: The Author. [4to, cloth, $3.]

Lethaby, W. R.=Architecture, Mysticism and Myth. London: Percival & Co.

Lunge, George, *Ph. D.*, and Hunter, Ferdinand, *Ph. D.*—The Alkali-Makers Handbook. Tables and Analytical Methods for Manufacturers of Sulphuric Acid, Nitric Acid, Soda, etc. Second edition, revised. New York: D. Van Nostrand Co. [12mo, cloth, p. 184, $3.]

Maycock, W. Perren.=A First Book of Electricity and Magnetism, for the use of Elementary Science and Art and Engineering Students, and General Readers. Illustrated. London: Whittaker & Co. [8vo, cloth, $1.]

Peters, Dr. Edward D.=Modern American Methods of Copper Smelting. Second edition, enlarged. Illustrated. New York: Scientific Publishing Co. [8vo, p. 398, cloth, $4.]

Roberts-Austen, W. C., *C. B., F. R. S.*—An Introduction to the Study of Metallurgy. Illustrated. London: Charles Griffen & Co., and Philadelphia: J. B. Lippincott & Co. [8vo, cloth, p. 292, diagrams.]

Rowell, Harvey.—Manual of Instruction in Hard Soldering. New York: E. & F. N. Spon & Co. [12mo, cloth, p. 56, 75 cents.]

Taylor, R. W. C.—The Modern Factory System. London: Kegan Paul, Trench, Trübner & Co.

Trevert, Edward.—Electricity and its Recent Applications. Lynn, Mass: Bubier Publishing Co. [p. 346.]

Vosmaer, A.—The Mechanical and other Properties of Iron and Steel, in connection with their chemical composition. New York: E. & F. N. Spon & Co. [12mo, cloth, p. 203, $2.50.]

Wood, Sir Henry Truman.=Light. An Elementary Treatise. Illustrated. London: Whittaker & Co. [12mo, cloth, 75 cents.]

Worthington, Slack.—Politics and Property: A compromise between Democracy and Plutocracy. New York: G. P. Putnam's Sons.